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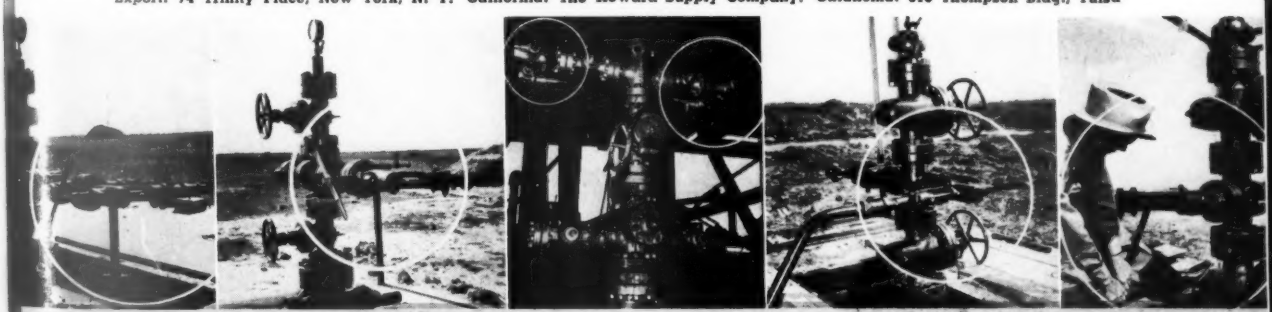

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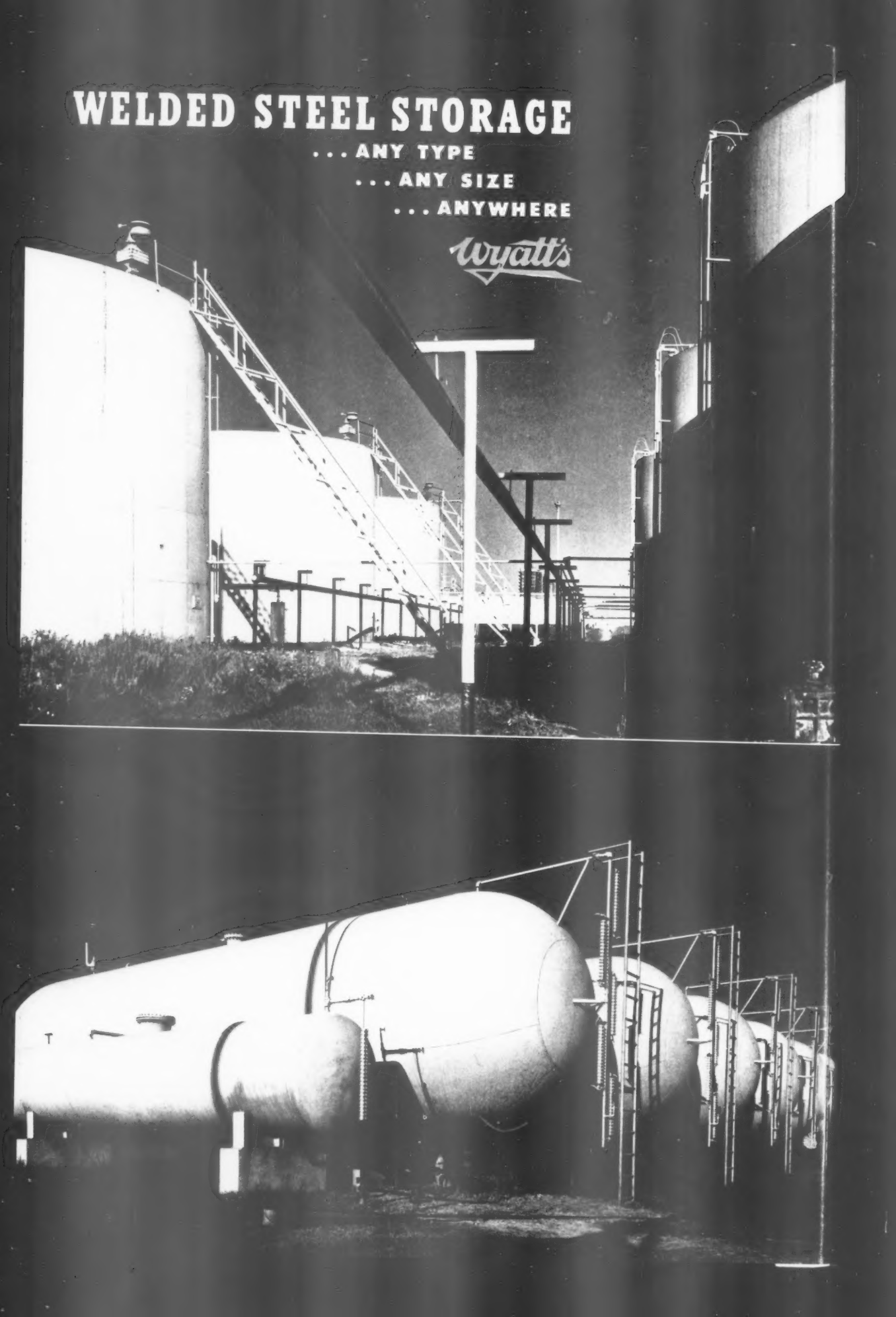
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PETROLEUM PUBLISHING COMPANY

211 S. CHEYENNE AVE., TULSA 1, OKLAHOMA

Subscription rate to the petroleum industry, United States and foreign, 1 year, $3.00. Single copies, 20 cents. Back copies, when over a year old, 50 cents. Entered as second-class mail matter at Tulsa, Okla., under Act of March 3, 1879. Copyright 1945, by The Petroleum Publishing Co.

Vol. 44, No. 32 December 15, 1945

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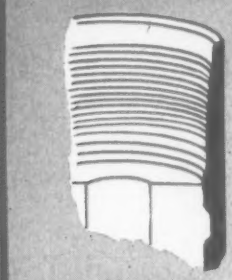

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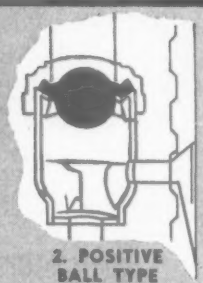

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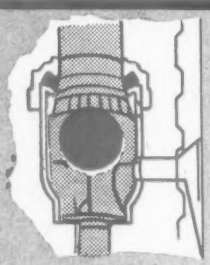
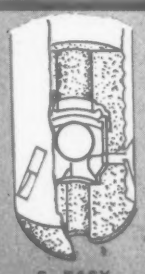


3. AMPLE CIRCULATION AREAS

4. BAFFLED WHIRLER PORTS



5. EASY DRILLABILITY

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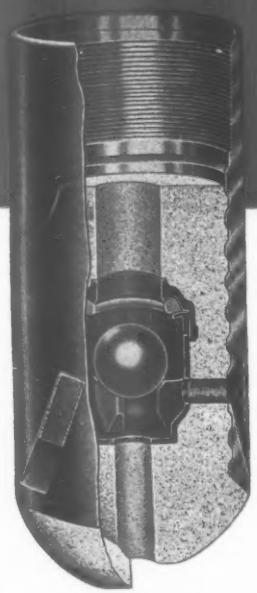

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1. *Strength*—The seamless steel casing shoe into which the concrete plug and plastic Ball-Type Valve Assembly are securely anchored, provide a unit that has the *strength* to float the longest and heaviest string of casing with an ample factor of safety.

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3. *Ample Circulation Areas.* The correctly designed, streamlined Valve Assembly provides passageways ample for any circulating or cementing operation.

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BAKER OIL TOOLS, INC.
Houston—LOS ANGELES—New York

the OIL AND GAS JOURNAL

Trends

Crude-Oil Production By States—Page 140

CRUDE-OIL STOCKS 218,845,000 bbl. as of Dec. 1—down 518,000 bbl. One year ago 221,591,000 bbl.

GASOLINE STOCKS 85,976,000 bbl. as of Dec. 1—up 2,792,000 bbl. One year ago 80,689,000 bbl.

RESIDUAL FUEL-OIL STOCKS 46,534,000 bbl. as of Dec. 1—up 60,000 bbl. One year ago 61,944,000 bbl.

GAS OIL AND DISTILLATE STOCKS 44,274,000 bbl. as of Dec. 1—down 984,000 bbl. One year ago 45,385,000 bbl.

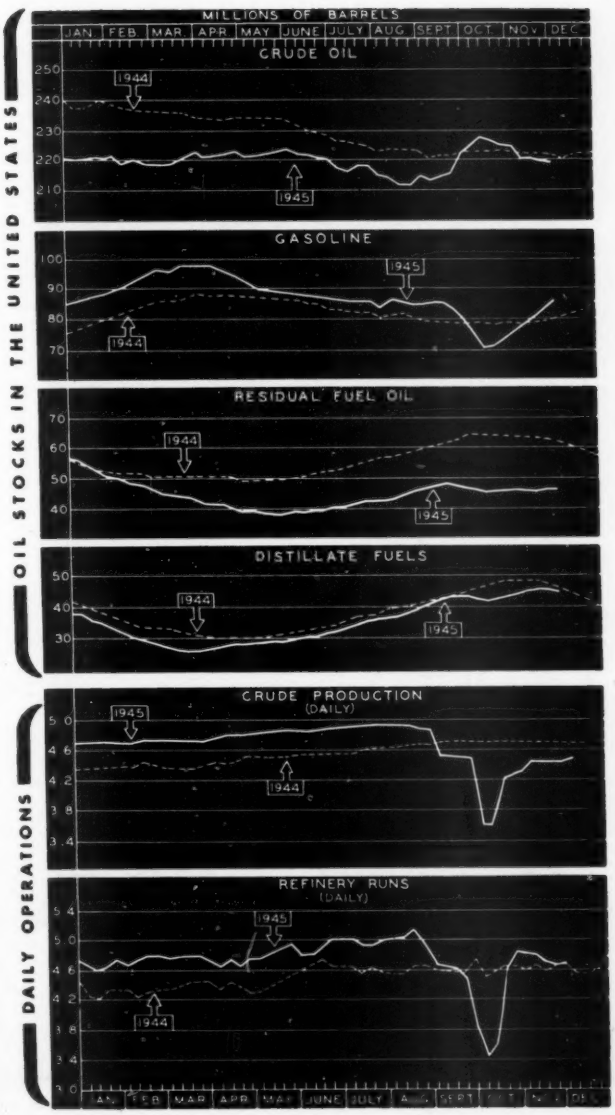
CRUDE-OIL PRODUCTION 4,493,100 bbl. as of Dec. 8—up 53,500 bbl. One year ago 4,705,450 bbl.

REFINERY RUNS 4,690,000 bbl. daily week ended Dec. 1—up 42,000 bbl. One year ago 4,725,000 bbl.

ONE of the problems having a direct bearing on postwar operating trends of which more will be heard in the future has to do with the determination of demands for petroleum products in this country. The war-agency projections and controls which gave the industry the yardstick on which to base its operations have ended. The industry in the past has had its own economic-committee reports which have been helpful in indicating demands over periods of several months or longer but these do not fill the requirement of monthly revisions needed by the state allocation bodies and the industry.

IN the prewar period the Bureau of Mines provided a monthly estimate of total crude-oil demands and this projection was generally accepted and used within the industry. The B of M demands estimates previous to the war were largely based on gasoline requirements. At that time it was possible to estimate these demands from motor registrations, motor-vehicle sales and general business trends and other factors affecting seasonal requirements. Despite the obvious limitations of this method of projecting over-all demands, the results were generally satisfactory.

IT is now felt that the prewar method of estimating demands will have to be revised to conform with changed conditions. It is apparent that this has been done in the B of M estimates of recent months. It is contended that the percentage relationship among petroleum products has so changed since 1941 that total figures based on gasoline alone will result in deficiencies or surpluses of other products. For example, it is pointed out that a refinery level of operation which would supply all the gasoline required would result in shortages of residual fuel oil and some of the intermediate products. Supplies of kerosene and distillates are inadequate at this time at several important consuming points. Reflecting this situation the B of M estimates of domestic crude-oil requirements have assumed a sustained or additional importation of low-gravity crude oils and fuel oil. This has brought criticism from the Independent Petroleum Association of America which objects to a bureau program "based upon the ability of importers to supply our domestic markets." It is assumed that this situation will receive further study with recommendations from within the industry.



Petroleum to Supply All Butadiene Next Year

by Henry D. Ralph

WASHINGTON.—Alcohol has been completely washed out of the synthetic-rubber program, and all butadiene scheduled for 1946 production will come from petroleum plants.

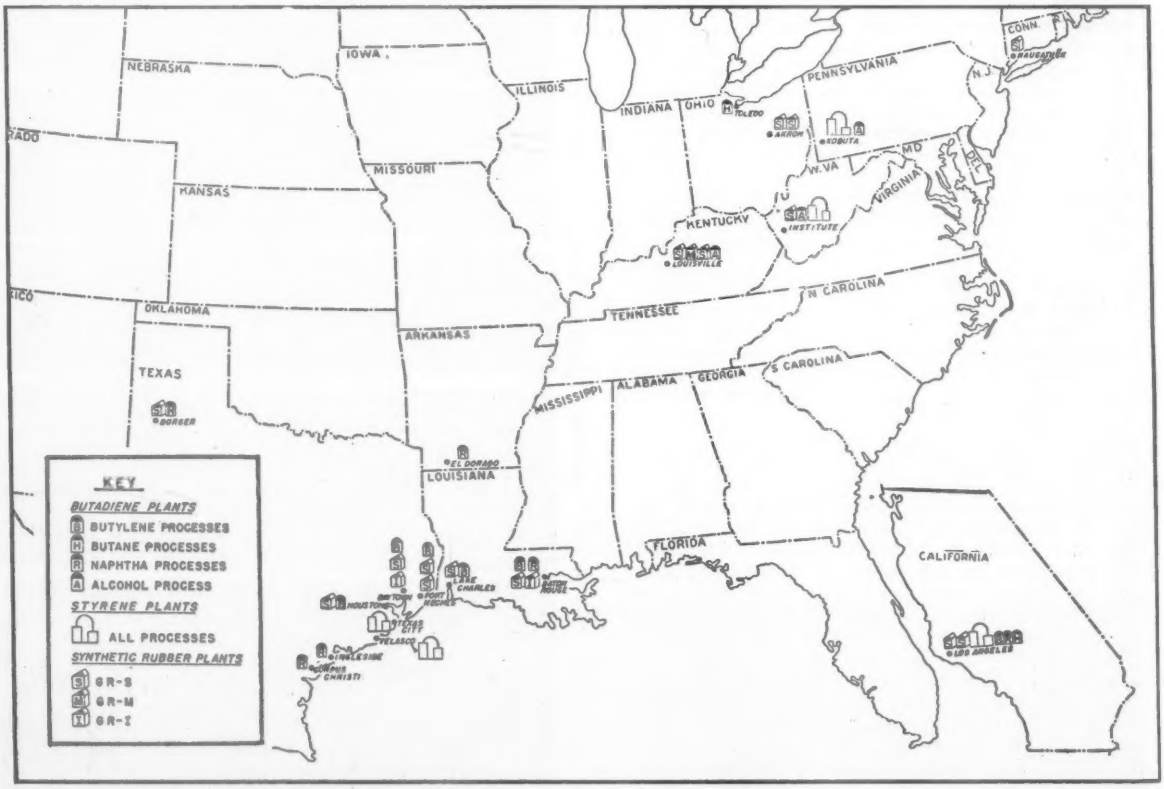
The new program just announced by the Office of Rubber Reserve, Reconstruction Finance Corp. calls for approximately 413,000 tons of butadiene from which slightly less than 600,000 tons of GRS synthetic rubber will be made next year. This amount, plus some 300,000 tons of natural crude rubber expected to be imported, is expected to meet all demands of rubber-fabricating factories, but there is sufficient flexibility in the program so that the output of butadiene from petroleum could easily be stepped up if demands increase.

All eleven units of the alcohol butadiene plants are being closed down and will be off production by the end of the year. These are four units operated by Carbide and Carbon Chemicals Corp., Institute, W. Va.; three units operated by Carbide & Carbon at Louisville, Ky.; and four units operated by Koppers Co., Inc., at Kobuta, Pa. They represent an investment of approximately $117,000,000, and will be retained by the Government in standby condition for the present. These units had a total rated capacity of 220,000 short tons of butadiene per year, but proved able to exceed this by substantial margins, and in 1944 they produced 361,734 tons, or 64 per cent of total output. In spite of their efficiency, and the fact that plant investment per ton of product is far less than the petroleum butadiene plants, their butadiene was very expensive because of the high cost of alcohol used as a charge stock. Butadiene from alcohol cost the Government 40 cents per pound compared with 8 to 10 cents for petroleum. This cost factor is the reason for shutting them down, since the RFC is under instructions to operate the synthetic-rubber program on an efficient and economical basis.

Three petroleum butadiene plants are also being closed down. These are the plants operated by Humble Oil & Refining Co. at Ingleside, Tex., Lion Oil Refining Co. at El Dorado, Ark., and Taylor Refining Co. at Corpus Christi, Tex.

All three of these plants were refinery-conversion projects, started late in the program, and all use the naphtha cracking process which is more expensive than the other petroleum butadiene processes in use. The Taylor plant has a crude butadiene capacity of 2,600 tons per year but no purification equipment. The Humble plant has a crude butadiene capacity of 7,000 tons per year and additional purification equipment to handle the crude butadiene from the Taylor plant, or a total of 9,600 tons. The Lion plant has a crude butadiene capacity of 3,500 tons per year but no purification equipment, its product being shipped to the Baton Rouge butadiene plant of Standard Oil Co. of New Jersey for purification.

The government equipment in these three plants is more or less intermingled with privately owned refinery equipment. The federal



Locations of government synthetic rubber plants

contract requires that the refineries be restored by the government to substantially their previous condition, less normal wear and tear. This means that these butadiene plants cannot be retained in standby condition and the government equipment will be declared surplus and either removed or sold for salvage value. These were the three smallest butadiene plants in the program and were not part of the original plan but were added later in 1942 at the request of the rubber director to provide an additional margin of butadiene capacity.

The naphtha cracking process was recognized from the start as quite expensive because the yield of butadiene is only 3 or 4 per cent, and successful operation of such plants depends on the ability to utilize the many other byproduct materials.

There are two other naphtha cracking butadiene plants which will remain in operation for the present, those operated by the Standard Oil Co. of New Jersey at Baton Rouge, La., and by the Southern California Gas Co. at Los Angeles, Calif. The Baton Rouge plant will be operated chiefly for its byproducts, such as isoprene feed stock and isobutylene for the butyl rubber program. The Los Angeles plant is useful chiefly for its production of ethylene for the styrene program and other byproducts, and because its output is well related to the Southern California synthetic-rubber program, it being a tandem operation with Shell Union which purifies its crude butadiene. Even when these byproducts are taken into consideration the cost of butadiene from these two naphtha plants is in the neighborhood of 21 or 22 cents per pound, which is still cheaper than the alcohol plants at present prices of alcohol.

All the remaining petroleum butadiene plants will be kept in operation at close to their rated capacities. While most of them were completed much later than the alcohol butadiene units, and some of them had difficulties in their initial operations, they are all now producing at or somewhat above rated capacities and their output could easily be increased by additional feed stocks.

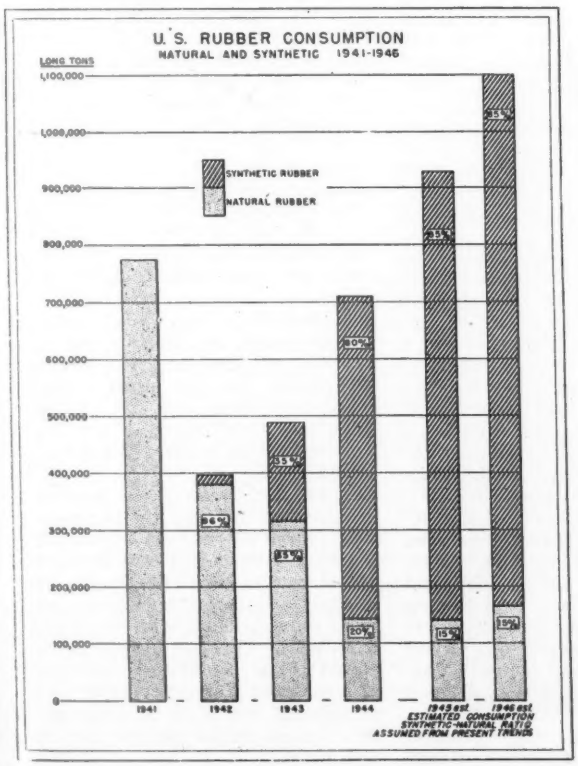
The 1946 butadiene program of the RFC has been tentatively set as follows:

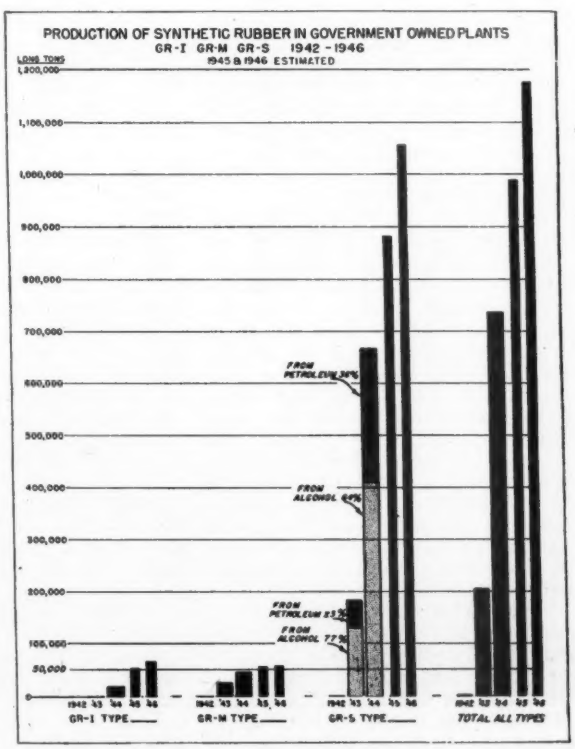
Company and location—	Short tons
Cities Service Refining Co., Lake Charles, La.	55,000
Humble Oil & Refining Co., Baytown, Tex.	30,000
Neches Butane Products Co., Port Neches, Tex.	108,000
Phillips Petroleum Co., Borger, Tex.	50,000
Shell Union Oil Co., Torrance, Calif.	25,000
Southern California Gas Co., Los Angeles, Calif.	30,000
Sinclair Rubber, Inc., Houston, Tex.	47,000
Standard of New Jersey, Baton Rouge, La., butylene plant	15,000
Standard of New Jersey, Baton Rouge, La., naphtha plant	8,000
Sun Oil Co., Toledo, Ohio	12,000
Standard Oil Co. of Calif., El Segundo, Calif.	15,000
Spot purchases from private producers	18,000
Total butadiene	413,000

This quantity of butadiene will produce about 48,000 long tons of GRS rubber per month, or slightly under 600,000 tons per year, but RFC officials feel confident that these same butadiene plants could easily produce 450,000 tons of butadiene in 1946 if required.

All of the present copolymer plants will remain in operation. They have a rated capacity of 705,000 long tons per year and in 1944 actually produced 668,840 tons of GRS rubber. Now that pressure for maximum output is gone they will be operated on three 40-hour shifts per week, with a 48-hour week-end shutdown, and with some changes in temperature and operating methods which will reduce capacity somewhat but give a better end product. On this basis their annual capacity will be approximately 580,000 long tons, which just balances the butadiene output of the petroleum process plants after closing down the three inefficient naphtha plants.

This production figure also coincides with consumption estimates of around 900,000 long tons next year, of which about 300,000 tons is expected to be natural crude imported from the Far East. Should crude imports fall short of expectations the synthetic output could be stepped up without much diffi-





culty. Stocks of GRS in the United States are now about 179,000 tons, while the normal working inventory of processing plants is about 55,000 tons, so the excess inventory is considered an ample cushion for any contingency.

Thus, the rubber situation, for the immediate future at least, is in good balance, with petroleum butadiene capacity well tailored to the consumption of the polymerization plants and to the anticipated consumer demand for synthetic rubber. Neoprene production is being cut back somewhat, but butyl rubber output will remain at capacity for some time. Styrene production is being reduced to conform with the lower operating rate of the copolymer plants by closing down the government-owned plants at Institution, W. Va., and greatly reducing the production of the plant at Kobuta, Pa., both of which operated on ethylene from alcohol.

The cost of producing synthetic rubber on a peacetime basis has not yet been determined with any exactitude, since much depends on the price of feed stocks and the costs of operating plants under normal conditions and at optimum capacities. Last spring RFC figured that its average cost of producing GRS was 30 to 31 cents per pound, including butadiene at an average cost of 33 cents, styrene at 10 cents, and copolymerization at 4.9 cents per pound of synthetic rubber produced.

That estimate was based on plant costs, exclusive of Washington administrative expense, interest, research expense, plant amortization, and sales expense, but usually including the home office management expense of the private company operating the plants for the government, and including payment of royalties at rates lower during the war than they will be with a postwar adjustment.

The high price of alcohol has been the chief factor in the price of synthetic rubber, since alcohol was the base for more than half of the butadiene and much of the styrene during most of the program up to now. Throughout the war alcohol for the rubber program had a price of 90 cents per gallon, plus transportation costs of 1 to 3 cents, making butadiene by this process cost 40 cents per pound. If sufficient alcohol should become available at 15 to 25 cents per gallon, butadiene could be produced from it for 8 to 12 cents per pound, making the cost of GRS rubber about 11 to 15 cents per pound.

However, if butylene has a postwar price of 10 cents per gallon the cost of butadiene made from it would be 5.1 cents per pound of GRS and the cost of GRS would be 10.7 cents per pound. If butylene is priced at 4 cents per gallon the cost of GRS would be reduced to 9.4 cents per pound by use of this process exclusively. In these estimates RFC assumed that the cost of styrene would be 1.1 cents per pound of GRS produced and copolymer costs would be 4.5 cents per pound. The actual figures for the entire program as of last winter, expressed in cents per pound of GRS, were butadiene 23.5, styrene 2.2, polymerization 5.0, total cost 30.7.

But last winter, under wartime conditions, one well-integrated group of plants, using exclusively butadiene and styrene made from petroleum feed stocks showed these costs: butadiene 4.9 cents, styrene 1.4, conversion 4.6, total cost 10.9 cents per pound of finished GRS.

The butadiene plants remaining in the rubber program include the two high-cost naphtha plants and three plants using the butane dehydrogenation process — those operated by Sun, Phillips, and Standard Oil Co. of California. All the others use the butylene dehydrogenation process.

When the RFC made its cost estimates last winter none of these plants had been sufficiently stabilized to establish their potential operating costs. However, one of the larger butylene plants reported butadiene costs of less than 7 cents per pound. Average operating costs of the butylene plants was expected to settle down to a level of approximately 4 cents per pound of butadiene, exclusive of the cost of feedstock. Butylene at that time was being purchased at prices ranging from 8 to 12 cents per gallon, and yields of 60 and 70 per cent were being obtained. It was estimated that postwar prices of butylene would be in the neighborhood of 6 to 8 cents per gallon, which would make the cost of butadiene around 6 or 7 cents per pound—somewhat less than butadiene made from alcohol at the lowest conceivable alcohol prices. The butane process at that time had not yet produced adequate cost data, but there were indications that it might be able to produce butadiene competitively with the butylene plants.

Boyd Honored for PIWC Service

WASHINGTON.—Washington officialdom joined with oil industry leaders last Tuesday night (December 11) to pay tribute to William R. Boyd, Jr., and his distinguished war service as chairman of the Petroleum Industry War Council.

As a token of the esteem with which he is held within the industry and in appreciation of the selfless and successful service he performed in directing the oil industry's enviable war efforts, Chairman Boyd was presented with an oil portrait of himself and a silver waiter bearing the signatures of all those who served with him as members or on the executive staff of PIWC.

Cabinet officers, diplomats, senators, congressmen, army and navy officers, other public officials and men from all phases of the oil industry attended the dinner, at which Petroleum Administrator for War Harold L. Ickes and Deputy Petroleum Administrator for War Ralph K. Davies extolled Chairman Boyd as one of the founders of a new age in government-industry partnership.

Under Boyd's chairmanship PIWC became a highly activated war organization. As working partners, government and industry teamed together to develop nation-wide and world-wide programs of petroleum production, refining and transportation, thereby furnishing Allied military might with a victorious allotment of war's most vital and most used munitions.

Foremost among the projects planned, perfected and accomplished by PAW and PIWC were:

1. An industry-wide program embracing technological revolution for conversion of American refining capacity to the large-scale production of war products, such as 100-octane aviation gasoline, toluene, butadiene for rubber, synthetic alcohols, aviation lubricants and fuel oils.

2. Advancement of the nation's production and refining capacity to the highest levels of all time. By July 1945 production of crude oil reached an all-time peak of over 4,890,000 bbl. a day, augmented by some 300,000 bbl. daily of natural gasoline, representing an increase of over 1,000,000 bbl. a day since 1941.

3. The nation's aviation gasoline output arose from a mere 45,000 bbl. daily to more than 600,000 bbl. a day.

4. Petroleum transportation was revolutionized by the building of a network of pipe lines, with big-inch and little big-inch lines bringing more than 360,000,000 bbl. of petroleum across continent to war ports and industries of the Atlantic seaboard.

PIWC Chairman Boyd headed a group of oil industry representatives who served as advisors to Secretary Ickes and the American delegation of federal Government officials who recently consummated the agreement on petroleum with the British in London. This pact projects on a global plane cooperative discussion of petroleum problems related to international trade. It is now before the United States Senate awaiting ratification.

THIS WEEK

LABOR— Fact-finding panel to start refinery wage study next Monday. . . . Oil Workers International Union urged by O. A. Knight, president, to stand firm on 30 per cent increase—use "political arm" in pressing demands. . . . ¶Refiners currently free of labor trouble decline invitation to attend fact-finding parley in Washington. Others proceed with individual-plant settlements, mostly on compromise basis of 15 to 20 per cent raise in wage rates. . . .

PRODUCTION— National output averaged 4,493,100 bbl. daily last week, up 53,500. . . . ¶Mississippi's rise of 22,600 bbl. most significant. . . . Increase chiefly from Tinsley field where deeper pay is under development. . . . ¶New Devonian discovery in Andrews County, West Texas, flows 1,427 bbl. a day. . . . ¶Record glycerin shot of 5,000 qt. planned as experiment in Canada's Turner Valley field. . . . Engineers think 100-million-barrel increase possible in ultimate reservoir production, if theories prove correct. . . .

DRILLING— Week's completions, all wells, total 548, lifting 1945 aggregate to 23,538, about 500 ahead of 1944. . . . ¶One-hundred-well program planned in Oklahoma's Cement field. . . . Plan tied into natural-gasoline and repressuring project. . . .

LEGISLATION— Anglo-American oil agreement scheduled for hearings before Senate foreign relations committee January 17. Campaign launched by opponents to discredit agreement. . . . Attacks consist chiefly of reprinted newspaper articles and editorials from Texas. . . . Sponsorship of criticism undisclosed. . . . ¶Senate Bill 1634 introduced by Senator McCarran of Nevada, calling for broad control and development of natural resources. . . .

FOREIGN— Shows of oil reported in important Colombian and Ecuadorian exploratory wells. Shell's wildcat in eastern Ecuador might be forerunner of vast new Latin-American oil province. . . . Shell setting pipe in southern Colombian San Martin test to investigate showing of 14-gravity oil at 6,800 ft. . . . ¶Peru seems certain to enact new oil legislation favorable to resumption of private exploration and exploitation, reversing 5-year policy of nationalization. . . . ¶Iranian situation unchanged this week, leaving political trend in delicate balance. . . .

NATURAL GAS— Construction projects pushed from Texas Panhandle and Hugoton to Chicago and Detroit and from West Texas to Pacific Coast. . . . ¶Gas industry planning climax for Federal Power Commission hearings in Washington early next summer. . . . Regional hearings are merely preliminary. . . . Industry loans experts for preparation of important testimony which will go into the record next April or May. . . .

RUBBER— Petroleum butadiene plants given exclusive assignment for all 1946 synthetic-rubber requirements. . . . RFC follows mandate to preserve least expensive plants in retaining petroleum facilities, inactivating alcohol installations. . . . ¶Rumors persist that passenger tires will be removed from rationed list but supply shows no improvement. . . .

PRICES— Ceiling prices on kerosene and fuel oil retard production. . . . Refiners reluctant to increase output of low-price fuels. . . . Supply shortage on East Coast becoming more severe. . . . ¶OPA will consider relief recommendations from advisory committees but prospects are slight for remedy, in time. . . .

TRIBUTE—Industry executives and government officials join in honoring war service of W. R. Boyd, Jr., chairman of PIWC. . . . His job of coordinating industry and government activity considered outstanding.

Two groups of oil-fire-fighting specialists from the United States were flown to eastern Venezuela last week to extinguish Mene Grande Oil Co. 6 RG, a deeper pay discovery in the Santa Rosa area. The well is reported flowing about 1,500 bbl. of oil daily with an estimated 100,000,000 cu. ft. of gas from below 10,000 ft.

Refinery Wage Panel Public Hearings to Start December 17

WASHINGTON.—Public hearings will open December 17 before the fact finding panel named by Labor Secretary Lewis B. Schwellenbach to investigate the oil industry wage dispute involving seized refineries now being operated by the Navy.

First day of the hearing will be taken up by submission of written briefs both from representatives of the companies involved and the Oil Worker's Union, CIO. Time limits have been set for oral presentation in support of briefs of both sides. Union representatives have asked for 1 day of oral argument of its case which, it is now expected, will be presented on an industry-wide basis so far as is possible. Management's case is expected to be kept to individual company presentations, as is provided for in the original order establishing the investigating board. Cross examination will be permitted, and at the close both parties will submit summaries of data presented.

Secretary Schwellenbach's original order, issued on November 27, set a 30-day time limit for the investigation and report by the panel recommending wage rates to be paid when the companies resume a 40-hour week. Delay in the organizational meeting of the panel until December 4, however, and length of time needed for preparing and presenting the material for both sides will make it highly difficult to meet the 30-day deadline and it is expected that the panel's final report will be delayed until the first of the year. Both management and labor representatives requested that the hearing be delayed to December 17 to permit adequate preparation.

Both contending parties have been asked to present complete data to form the basis for the panel's recommendations. The panel will also call on government sources for additional statistics and studies to aid in evaluating information presented by the union and the oil firms. Any material gathered by the panel itself will be submitted for discussion and objection by the companies and the union.

Assisting the panel will be Philip Brayton of the War Labor Board, who will serve as general aide, and Dr. Harry Doughty, of Bureau of Labor Statistics, who will direct the panel's own research.

Viewed as a guinea-pig for future strike settling, the December 17 hearings will be watched closely by Congress, now scheduling consideration of numerous bills based upon President Truman's recommendation that fact finding boards, similar to the oil panel, be established under law.

Frank Porter Graham, chairman of a three-man panel appointed by Secretary Schwellenbach to investigate the labor dispute in the oil industry, is president of the University of North Carolina, and one of the members of the National War Labor Board, representing the public.

Appointed to the board on January 12, 1942, Dr. Graham brings to it a thorough experience of dealing with matters affecting the public welfare. He has helped frame important legislation, such as the Social Security Act, and has always interested himself in any case affecting the rights of the individual.

President of the University of North Carolina since June 1930, Dr. Graham has also served the public in such capacities as vice chairman of the National Consumers Advisory Board, chairman of the National Advisory Council on Social Security and as a member of the National Emergency Council.

Dr. Graham was also a public member and vice chairman of the National Defense Mediation Board and since January 4, 1942, has been a member of the Maritime War Emergency Board with Captain Macauley and Dr. John Steelman in the field of maritime labor relations.

Otto S. Beyer, another member of the panel, is labor relations advisor to the U. S. Maritime Commission and the War Shipping Administration and labor consultant for the Bonneville Power Administration and the T.V.A.

Authority on Wage Relations

An authority in the field of labor relations, Beyer was a consulting engineer in the development of labor-management cooperative programs with several railroad systems and industrial companies in the period 1920-33. In the latter year he became director of labor relations under the Federal Coordinator of Transportation. In 1936 he became a member of the National Mediation Board, serving with that board until 1942 and as its chairman, 1937-40. He was director of the division of transport personnel, Office of Defense Transportation, beginning in 1942, and was a member of the War Manpower Commission representing the transportation industry.

Paul Eliel, the third member of the panel, is director of the division of industrial relations of the graduate school of business, Stanford University. He is also chairman of the Pacific Coast Maritime Industry Board of the War Shipping Administration as well as special representative and chief hearing officer for the National War Labor Board.

In 1941 Eliel served as a member of an impartial commission of the WLB in the West Coast employer's negotiating committee case. He was examiner in a dispute involving the hotel employers of San Francisco and various hotel employes' unions. In February of 1942 he served as investigator in the American Smelting & Refining Co. case in San Francisco.

Marshall Named Chairman Of Annual Tax Forum

T. H. Marshall, Anderson-Prichard Oil Corp., Oklahoma City, was elected general chairman of the Mid-Continent Oil and Gas Association's annual tax forum, which, for the first time since the beginning of World War II, met in Tulsa December 4 and 5. E. E. Hunter, Humble Oil & Refining Co., Houston, was chosen general vice chairman. Petroleum attorneys, accountants, federal-tax specialists and others from oil-producing areas of the Southwest attended the sessions, which were devoted to discussion of problems relating to taxation.

Committee chairmen and vice chairmen for the ensuing year were named as follows: Federal income taxes—L. E. Frensley, Magnolia Petroleum Co., Dallas, chairman; V. G. Gillingham, The Texas Co., Houston, vice chairman. Federal excess profits taxes—O. W. Meyers, Sinclair Prairie Oil Co., Tulsa, chairman; Charles R. Bell, Kerlyn Oil Co., Oklahoma City, vice chairman. Federal payroll taxes—A. F. Wolfe, Stanolind Oil & Gas Co., Tulsa, chairman; H. H. Boyer, Sun Oil Co., Dallas, vice chairman. Federal excise taxes—E. F. Brite, Skelly Oil Co., Tulsa, chairman; Riley Frick, Tide Water Associated Oil Co., Tulsa, vice chairman. Federal pipeline transportation taxes—P. H. Hunter, Interstate Oil Pipe Line Co., Tulsa, chairman; A. E. Groff, Shell Oil Co., Inc., Houston, vice chairman.

Continental Lets Contract For New Office Building

PONCA CITY, Okla.—Continental Oil Co. has awarded a contract for construction of an office building to provide space for 175 employes. It will be erected near the five-story general office building. A one-story structure of modern design, the new building will be 350 ft. long and 75 ft. wide, of stone and stucco. Appointments will include summer and winter air conditioning, acoustical ceilings, tile floors, fluorescent lighting, and glass-block windows.

FOUNDED IN 1910

BY PATRICK C. BOYLE

the OIL AND GAS JOURNAL

Causes and Cures

THE witness who can get across a few simple facts to the hangover war agencies and other investigators relative to the cause and cure for the projected and much publicized petroleum famines of the future would be deserving of the highest honors from the oil business and the entire nation.

It is hoped that the O'Mahoney committee out of the maze of testimony that has been presented to it will be able to screen this information. Otherwise it will prove to be just "another investigation" of no value in establishing a base for immediate and long-range petroleum policies.

That the cost of operation from the finding of oil to its final distribution as finished products has increased no one denies outside the official price-fixing group at Washington. All operating expenditures are now subject to the advances that have taken place in every phase of our civilian economy. Yet the Washington attitude is that price ceilings must continue in effect until all oil markets are saturated and there is no danger of advances with the desirability of reductions being suggested in some quarters.

At the same time many of our national leaders, including the military, profess to be alarmed regarding the future petroleum supplies of this country. Millions are to be spent in research looking to the development of petroleum substitutes and complicated international programs involving outside supplies are being outlined.

The truth is that the causes and cures for any petroleum shortages in this country, for the forseeable future, largely rest within our own boundaries. The basic cause for any deficiencies of the future will stem from inadequate returns to those who have the supply responsibilities.

The petroleum industry has within itself the techniques and flexibility with which it can, if given the opportunity, effect its own cures.

As returns to operators move up several basic developments get under way. Those in charge of exploration approve wildcat programs not now justified and out of these risks come additional proven reserves. In production practices new and old recovery methods become commercially feasible and applicable to new areas.

Plant operators over the past 30 years have more than doubled gasoline yields with quality steadily improved. This has been done despite the fact that in recent years the average base price for gasoline has been less than 6 cents per gallon. Operators have the "know how" to add another 50 per cent to gasoline yields if justified by plant returns. The same situation applies to other essential products of petroleum.

"But this means higher prices to consumers." Certainly it does but not prices out of line with the general commodity trends. Gasoline would continue to have the lowest index of any of the major commodities. Motor fuels and other products would still be far cheaper in price and superior in quality than any of the substitutes in which governmental investigators are displaying so much interest at this time.

The point is that new petroleum supplies and the conservation of those already at hand are a matter which can be worked out within the industry itself if it is permitted again to run its own business. The governmental inconsistency of being fearful of something that could happen and at the same time doing those things which assure that it will happen should be apparent to everyone.

Utilization of Natural Gas In the United States

*by G. G. Oberfell**

This is a condensed summary of the paper presented before the Chicago Section, American Institute of Mining and Metallurgical Engineers, December 5. An examination of the past and present uses of natural gas, the author concludes, clearly indicates its superior qualities for fuel purposes. While considerable quantities are employed in carbon-black plants, nevertheless such use disappears when higher-priced markets and pipe-line outlets become available. The future prospects for the use of natural gas for fuel purposes is very bright.

Natural gas as a raw material in the manufacture of chemicals is of considerable economic importance to the chemical industry, but the quantity of natural gas used for producing chemicals is and probably will continue to be relatively small in comparison to the amount used for other purposes.

Natural gas is a more economic raw material than coal for conversion to liquid hydrocarbons by the Fischer-Tropsch process. Modifications of the Fischer-Tropsch process, using natural gas, will undoubtedly find useful applications, particularly where the process can be combined with other processes or with existing facilities. The production of natural gasoline and the manufacture of chemicals afford opportunities for such combinations. However, without the economic advantages of such combinations, the available information indicates that as a means of producing gasoline alone the Fischer-Tropsch process would not be competitive with present refinery operations, using crude oil as a raw material, under present prices. Furthermore, the peak of gasoline production from natural gas by the Fischer-Tropsch process will undoubtedly amount to only a minor proportion of the total gasoline supply of the nation.

ALTHOUGH the largest volume use of natural gas has been, is and in all probability will continue to be as a fuel for domestic and industrial heating, the various market outlets for natural gas, both as a fuel and as a raw material for the chemical industry, continue to be an interesting subject, particularly in this period of unexcelled industrial and research activity. Much has been written in recent years on the subject of natural gas, as is evident from the voluminous literature. The best that I can hope to do in this paper is attempt to condense and correlate the available information and make predictions as to the probable future of the natural gas industry.

Natural gas is considered a preferred type of fuel for domestic uses and also for various industrial heating applications where ease of control, fuel uniformity, freedom from ash, etc., are of primary importance.

The importance of existing investments in producing, manufacturing and transportation facilities must be considered. Underloaded gas-transportation systems may be used to transport additional volumes of gas at very low costs since in such instances the only extra costs incurred are those for handling the additional volumes (so-called incremental costs). In marketing of all types of fuel, intermittently available supplies can be sold at abnormally low rates, still realizing attractive profits. Such underloaded facilities may be employed to handle additional quantities of fuel or raw material for the normally less attractive markets or they may be used to support a new development. For example, in specific cases processing facilities for natural gas and natural gasoline may enable one to lower over-all costs of operation of a Fischer-Tropsch process for producing liquid fuel from natural gas. Likewise some war facilities may become useful in reducing investments for fuel distribution.

Faced with these important background factors, none of which can be ignored, the future possible outlets for natural gas constitute an interesting field for conjecture. Since the primary use of natural gas has been as a fuel, and since, in this application there has been and apparently will continue to be a steady and uninterrupted increase in the volumes so utilized, the most immediate prospect is one of domestic and industrial load building.

For the past 10 years the domestic natural gas load (home use) has shown a consistent increase. During this period this load has increased 87 per cent. The increase in 1944 over 1943 was 9.4 per cent. During the last year the increase in number of customers was 2.8 per cent. This greater percentage increase in gas load than in number of customers illustrates the generally accepted theory that natural gas is gaining in acceptance by its present users. One can immediately recognize the stability and strength of this load.

At the end of 1944 there were 8,578,000 domestic users of natural gas, the number having increased 16 per cent since 1935.

An increasing domestic gas load can be expected as our population turns away from the many inconveniences and deficiencies of outmoded heating appliances. Expansion into the fields of gas-fired refrigeration, home freezers for quick-frozen food storage, space heating and water heating offer additional possibilities as domestic load builders. In some localities, even domestic air conditioning is now being commercialized. However, gas will have competition for the expanded domestic load, with the chief competitor in the fields of domestic refrigeration, cooking and water heating continuing to be electricity. It can be expected also that the use of the complementary fuel, liquefied petroleum gas, will be greatly extended in the domestic field, primarily in suburban areas and in localities where gas distribution facilities are not available. It is also expected that the use of the coal and fuel oil for general house heating in well-designed and efficient equipment, operating with a new high standard of cleanliness, will show a decided increase and may ultimately arrest the trend toward the use of gas for this purpose.

Long-Range Prospects

The prospects for natural gas as an industrial fuel over the next several years appear to be bright since we are undoubtedly entering a period of extreme industrial activity. However, from a more distant viewpoint, the extension of natural gas use does not appear probable in those applications where the cost per heat unit is the prime factor. Those industrial loads where uniformity of fuel and close control of heating operations are of more importance than the cost per heat unit will undoubtedly be retained by natural gas and liquefied petroleum gas, and some further extensions can be expected.

The production of carbon black from natural gas is, and probably will continue to be, a transient use for this raw material confined mainly to the early life of gas fields and to those fields where pipe-line outlets for fuel gas are inadequate. The present use of gas for carbon black manufacture may be expected to decrease gradually in favor of the more profitable fuel markets. Of interest in this connection is the recent development on a commercial scale of an extremely flexible carbon black process which employs fuel oil and other liquid hydrocarbons as the starting material and which produces a much wider variety in quality of blacks than is possible by other well-known processes. The success which the product of this process has met in various carbon black applications gives us reasonable assurance of a source of carbon black when gas no longer will be available for its production at prices that will enable its present wide use.

Much publicity has been given the

*Vice president in charge of research and development, Phillips Petroleum Co.

postwar possibilities of chemicals, particularly the organic chemicals. Since the organic chemicals are "carbon chemicals," it follows that petroleum, natural gas, coal, agricultural and forest products are the primary raw materials. Extensive progress has already been made in the manufacture of chemicals from petroleum, and a substantial part of this progress has been accomplished by companies interested more in chemicals than in petroleum products. Strictly speaking, all compounds are chemicals, but the petroleum industry is rapidly beginning to think of chemicals as all of those new products from petroleum which are not used as fuels or lubricants.

As the principal products of the petroleum industry are fuels and lubricants, the majority of oil companies have, until recent years, directed their chemical research primarily to the manufacture of these products. Consequently, the majority of the new processes developed in the refining industry have been based to a steadily increasing degree on chemical reactions. Obviously the introduction of chemical knowledge in refinery technique will intensify the interest of refiners in the manufacture of chemicals. But more important than this is the abundance and variety of chemical raw materials resulting from the production and processing of oil and natural gas. Furthermore, many of the hydrocarbon raw materials available in the petroleum industry are in effect by-products of the many processes which are used by the refining industry, and for this reason they are ordinarily cheaper than raw materials from other sources. These facts are going to be important factors in the further development of chemicals from petroleum or natural gas.

In considering the manufacture of a chemical, the "conversion" state of the raw material to be used in the process is an important economical factor. All other things being equal, the less the number of steps through which the chemical raw materials must pass before emerging as a finished chemical product, the simpler and more economical will be the manufacturing process.

The manufacture of chemicals from oil and natural gas is certain to increase. However, the manufacture of chemicals, as compared with the manufacture of fuels and lubricants, calls for a different type of operation, characterized in particular by small quantities, higher investments, higher costs, higher research budgets, a higher degree of technical skill, and a higher obsolescence of process and product; that is, shorter life of process and product.

With the exception of synthetic fuels used primarily in aviation gasoline, the largest recent interest in the chemical field has been in synthetic rubber. The production of this material in 1944 was about 750,000 tons. Other products now manufactured in appreciable volumes from petroleum and natural gas hydrocarbons include the familiar antifreeze compounds, solvents, explosives, alcohols, and a veritable host of derivatives which constitute starting materials for many other products. The viewpoint of the chemists on these various developments is that the surface has barely been scratched and that further researches will bring quick results in the preparation of new and useful chemical derivatives from petroleum materials. The possibilities in the new field of synthetic plastics alone promise to make all the other petroleum chemical developments to date appear small by comparison.

Lest the impression be left that the chemical field is an unlimited one so far as market outlets are concerned, it is well to point out how relatively small such outlets generally are for these raw materials. Thus it was calculated recently that the entire 1944 production of wood alcohol could have been produced from a single gas well of 15 million cu. ft. daily capacity if near perfect conversion efficiencies were obtained.

Summarizing, it is interesting to note that the chemical uses today represent considerably less than 1 per cent of the total natural gas consumed.

Another possibility of a new outlet for natural gas is in the conversion of dry natural gas into liquid fuel hydrocarbons by means of the so-called Fischer-Tropsch process.

COMPOSITION OF TYPICAL FISCHER-TROPSCH PRODUCTS

(Weight per cent)

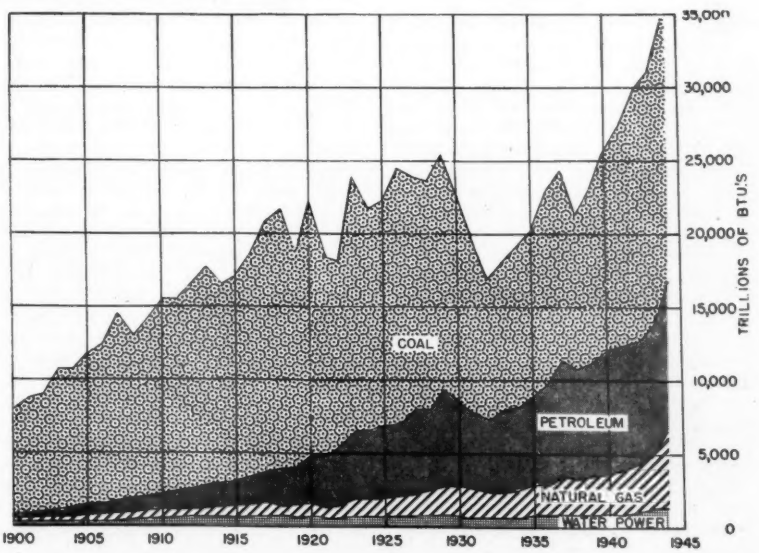
	Atmospheric pressure process (%)	Medium pressure process (%)
Liquefied petroleum gas	13	7
Gasoline	52	38
Diesel oil	26	30
Wax	9	25

As the hydrocarbons produced in the conventional Fischer-Tropsch process are principally of a straight chain-paraffinic nature, the antiknock quality of the gasoline is poor, but the cetane number of the diesel oil is high. The entire product can be handled readily in much the same manner as crude oil in conventional refining equipment to obtain products of desired specifications.

The yield of gasoline by the process when methane is used as the raw material is estimated at about four gallons per thousand cubic feet of gas. This gives us some indication of the approximate over-all efficiency of the process as currently practiced, since the yield figure would imply that only about 40 per cent of the heat content of the methane charged to the process

EFFICIENCIES OF GASOLINE PRODUCTION BY FISCHER-TROPSCH PROCESS

Raw material—	Raw material to produce one barrel of gasoline	Therms necessary to produce one barrel of gasoline	Therms contained in one barrel of gasoline	Percentage of fuel value of raw material converted to gasoline
Coal	1,360 lbs.	163.0	50.5	31.0
Methane (European design)	505 lbs. (11,950 cu. ft.)	119.5	50.5	42.3
Methane (Possible future design)	440 lbs. (10,450 cu. ft.)	104.5	50.5	48.3



Energy content of minerals and water power used to supply annual demand

would be recovered in the liquid product.

From 1,000 cu. ft. of methane, allowing none for fuel requirements, it is theoretically possible to obtain about 6.5 gal. of motor fuel. The fuel value of this 6.5 gal. of motor fuel would be about 75 per cent of the fuel value of the original 1,000 cu. ft. of methane. Therefore, the maximum fuel value recoverable is about 75 per cent. In practice, however, even with 100 per cent reaction efficiency as above, some methane will be required for fuel purposes. Consequently yields will always be less than 75 per cent of the fuel value of the methane used to produce it.

For every cent of cost per 1,000 cu. ft. of methane with 50 per cent of the fuel value converted to gasoline, the raw material cost alone will be ¼ cent per gallon of gasoline.

Competitive Position With Coal

The competitive position of natural gas with respect to coal as a raw material for Fischer-Tropsch type processes in the United States will depend upon the relative economics, efficiencies of utilization and over-all reserves of coal and natural gas available. Costs for gasoline manufactured from natural gas as low as 5 cents per gallon have appeared in the literature, based on 10 per cent return on investment and assuming certain favorable local conditions. At any rate, there is general agreement that gasoline from dry natural gas as a starting material is cheaper to produce than the same product from coal as the raw material. The raw material cost alone of coal per barrel of gasoline would probably average somewhat greater than the cost of natural gas. For example, with natural gas at 5 cents per 1,000 cu. ft., its cost per barrel of gasoline produced (10,450 cu. ft. per barrel) is approximately $0.52. To compare favorably with this cost, the price of coal per ton would have to be about $0.77 on the basis of 1,360 lb. of coal per barrel of gasoline produced. With natural gas at 10 cents per 1,000 cu. ft. the equivalent price of coal would be $1.54 per ton. On the basis of conservative published estimates, the synthesis process utilizing natural gas will not be able to compete with present refinery methods utilizing crude petroleum until the price of crude reaches about $1.75 to $2 per barrel. On the basis of experimental data not yet confirmed by large scale commercial operations, gas may be competitive with crude oil under special circumstances.

The intense interest during recent years by several oil companies promises to crystallize in the near future the commercial development possibilities of the Fischer-Tropsch process for conversion of natural gas in this country. The success of this development would bring new problems of integrating it with the natural-gasoline industry, with which it is complementary in that it affords an outlet for residue gas and for dry gas without a pipeline market, and with the natural-gas fuel industry with which it promises to compete for that gas. Furthermore, the Fischer-Tropsch process has a very promising limited application to the synthesis of raw materials for synthetic lubricants, detergents, edible fats, solvents, aldehydes, alcohols, acids, etc., as practiced in Germany during the recent war.

If natural gas were used at the estimated 1944 rate of consumption our proven gas reserves would last a little over 35 years. Yet we know that a large amount of the gas used was sold at very low prices only because there was no higher price market available. Therefore, we can state quite assuredly that as higher price markets for natural gas are developed, or greater value is placed on this material, the low price markets such as carbon black, natural gas for power, and low price industrial uses will disappear. Such being the case, I am firmly of the opinion that our natural gas resources will not be exhausted prior to those of crude oil.

No Satisfactory Substitute

Although there are many source materials which could be used as petroleum substitutes, such as agricultural products, oil shale, tar sands and coal, there is yet no satisfactory substitute for petroleum in times of national emergency, due to the additional manpower and equipment that are necessary to utilize such substitutes during a national emergency. Petroleum is a convenient, high grade and valuable raw material which requires fewer operating steps, and less new facilities for converting it into other materials. For this reason, the intelligent use of petroleum resources in order that there may be adequate supplies for use in any national emergency, is essential in the national interest. The same is true of all our natural resources. We should insure and assure that we have access to all strategic war materials, not only oil and natural gas, but also rubber, coal, iron, copper, aluminum, zinc, chromium, nickel, mercury, uranium, etc. Failing to do so, we should, by means of research, develop satisfactory substitutes for such materials with a backlog of the minimum productive capacity essential for immediate full scale war necessities until adequate war production capacities are installed. We should not repeat a mistake similar to that made with respect to rubber prior to World War II.

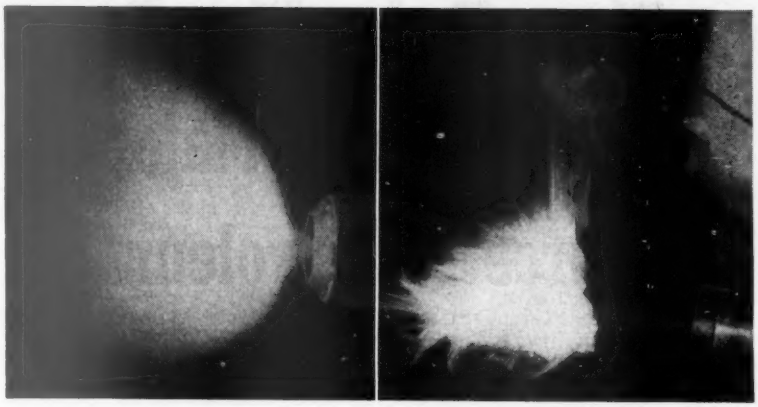
We do not know what may be the distant future quality of fuels and lubricants for the internal combustion engine. Carbon and hydrogen regardless of source are potential raw materials. We should continue to adequately investigate all sources, including agricultural products and coal. Some of the results of the large amount of research now being conducted by the petroleum industry will in future years find useful application in the conversion of coal and agricultural products to fuels and lubricants. Therefore, the research on petroleum and natural gas is supplementing and complementing the research financed by the Government on agricultural products and coal. This latter research has been prompted by the desire to find new and replaceable resources of liquid fuels for the internal combustion engine. The Government research program in petroleum should be expanded since it is obvious that the result of such research will find earlier application and thereby serve to prolong the life of our petroleum reserves; and to such an extent serves the same purpose as research work on the conversion of agricultural products and coal which, by all means, should be continued. However, it may come as a surprice to some that for at least the next 20 years the petroleum and natural-gas industries will in all probability be the primary beneficiary of any such research work on conversion of coal and agricultural products for the reason that these industries will undoubtedly be able to more economically utilize a greater portion of the results of such research in the manufacture of more and better fuels and lubricants.

Personnel Conferences Scheduled for January

NEW YORK.—Two personal conferences under the sponsorship of American Gas Association are scheduled for January.

The first Midwest conference under the chairmanship of C. C. Jolley, of Natural Gas Pipeline Co. of America, will be held at the Fontenelle Hotel, Omaha, January 8. All gas-company officials concerned with industrial relations problems in Arkansas, Colorado, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota and Wyoming will be welcome, A.G.A. announces.

The Southwest conference will be held at the Jung Hotel, New Orleans, January 11. Arrangements for the meeting are being made by the vice chairman, Howard Senyard, of Louisiana Power & Light Co. Gas company executives in the Southwest area concerned with industrial relations will find the sessions informative.



Left: Side view of Shell burner head. Even when burning out of the firebox, the new head exhibits remarkable flame-retention properties. Right: Side view of conventional burner head, showing ragged, unstable flame typical of inefficient combustion

Improved Combustion Head Announced

SEWAREN, N. J. — Prompted by the increasing use of fuels made by catalytic-cracking units, the Shell Oil Burner and Fuel Oil Laboratory has developed a new type of combustion head which is applicable to all gun-type domestic burners. It increases burner efficiency by achieving a more thorough mixture of oil and air, with a consequent reduction in the amount of cold-air intake required. Excessive quantities of cold-air intake tend to cool the combustion chamber and permit a large portion of the heat to escape up the flue. Smoke and carbon deposits are virtually eliminated due to the thoroughness with which the oil and air are mixed.

The new fuel oils have a higher heat content than prewar fuels, but require more thorough mixtures of air and oil for efficient burning and fuel economy. Shell marketing experts have estimated that by 1950 a total of 7,770,000,000 gal. of heating oil will be consumed in this country every year.

The operation of the new device, and methods used for testing its efficiency were demonstrated here in the Shell laboratory before a group of editors and writers. W. A. Sullivan, senior engineer of Shell's manufacturing department, New York, and E. B. Glendenning, manager of this laboratory, conducted the demonstration. The new combustion head will be made available to burner manufacturers under a license for incorporation in their burner units, and is expected to encourage the use of oil for domestic heating.

Burner Combustion Tests

During the course of investigations conducted in the Shell laboratory burner combustion tests were conducted on fuel blends containing varying concentrations of a representative catalytic distillate. In one series, the catalytic distillate was blended with straightrun distillate of a similar boiling range. In another series the same sample of catalytic distillate was blended in comparable concentrations with kerosene, so that this series varied in distillation characteristics as well as in hydrocarbon composition. These blends were burned in a domestic oil-burner set to bring out differences in tendencies to smoke. Throughout the tests the following conditions are held constant: burning rate, stack draft, and CO_2 in flue gas.

Tests conducted in the Shell laboratory indicate that catalytic fuels can be burned entirely satisfactorily if the oil is mixed thoroughly with air in the early stages of the combustion process. Cracked fuels show no greater tendency to smoke than straightrun fuels when the burner design effects the intimate mixing which is so important.

Mine-Detecting Jeep Recovers Cached Silver

DEVELOPMENT of special electrical devices which recovered $8,500,000 lost in Manila Bay, and perfection of a mine-detecting jeep are two of the newly revealed wartime accomplishments of Electro-Mechanical Research, Inc., of Houston. The concern is a subsidiary of Schlumberger Well Surveying Corp. The engineering was conducted by H. G. Doll, chairman of the board and director of research for Schlumberger, and his staff.

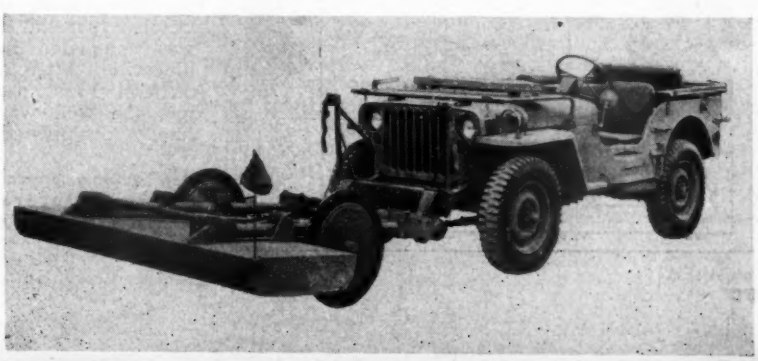
Loss of the huge amount of silver took place shortly before the fall of Corregidor in 1942, when 17 million Filipino pesos (worth 50 cents each) had been gathered from various sources and dropped into 110 ft. of water. The silver, along with gold and securities, was from the treasury at Manila. The latter were recovered by submarine, but because of the enormous weight of the silver, it had to be dropped in the bay to keep it from the Japs.

Although the exact location was mapped, the records were lost, but after the Americans recaptured Manila the Houston firm was asked for equipment to find the treasure.

The underwater electrical "fishing" equipment was flown to the operations and put to work. The silver was located after 2 weeks of surveying the bay. Fifteen Army and Navy divers picked up the coins, which were in small wooden boxes, at the rate of $5,500 per half hour.

The mine-detecting jeep, of which more than 200 units were made for the Army at the Electro-Mechanical Research plant, carries a large detector box in front on a two-wheel sulky (see cut). In operation, electrical circuits actuate mechanisms which instantly lock the brakes and release the clutch whenever the detector passes over a mine. This stops the jeep abruptly before it can run onto a mine, although the engine is not stalled. The jeep proved "a lot faster than walking," as well as very much safer than the old "down on the knees" prodding method of using a portable detector, according to Army service engineers.

H. G. Doll, who conducted the engineering in recovering the treasure. Below is shown the mine-detecting jeep on which the detecting equipment was mounted



MIDDLE EAST REPORT No. 12

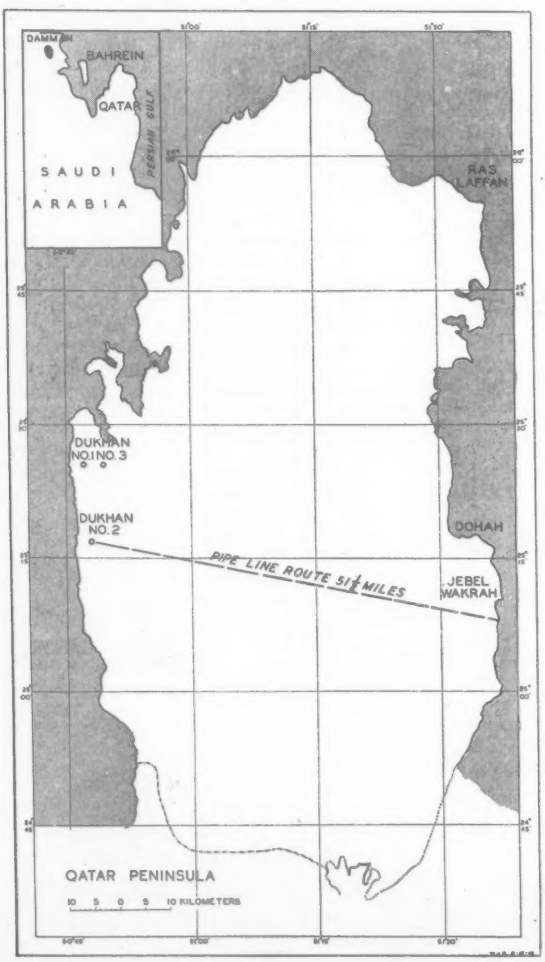
Plans Under Way To Make Qatar a Major Source of Petroleum

by C. O. Willson

QATAR, Persian Gulf.—As soon as needed equipment and materials are available, an important petroleum development will start on this peninsula of the lower Persian Gulf area with every indication that a field already proven will add substantially to the crude-oil production of the Middle East.

The peninsula consists of approximately 4,000 sq. mi. It connects to the Kingdom of Saudi Arabia as shown on the accompanying map and its oil field is part of a general oil area which includes Bahrein Island and the east coast of the mainland. In government, it is one of the independent shaikhdoms of the Persian Gulf. His Excellency, Shaikh Abdullah Ben Qasim ath Thani, is the Arab ruler and maintains his palace at Dohah. The British Government has treaty rights through agreements with the ruler.

The operating company is Petroleum Development (Qatar) Ltd., a company associated with Iraq Petroleum Co., Ltd., owner of a large concession in Iraq, with important crude-oil production in northern Iraq and pipe-line facilities connecting to the Eastern Mediterranean. The Qatar company maintains general offices at Manama on the south coast of Bahrein Island, the largest of the group, which is about 40 miles from the nearest shore of Qatar. Field headquarters are maintained near the discovery well of Qatar.



Map showing present and proposed future operations on Qatar Peninsula

Early Development

The concession, which covers the entire peninsula, became effective in 1935 and covers a period of 75 years. After considerable geological work, the first exploratory test was started in October 1938 and it was completed in limestone. After a difficult fishing job, the well was finally completed in 1940 with an initial estimated production of 5,000 bbl. daily of 36° A.P.I. gravity crude oil with a well head flowing pressure of 367 lb. The well is known as the 1 Dukhan.

The 2 Dukhan was completed 10 miles south of the No. 1 in March 1941. This well was also given an initial rating of 5,000 bbl. daily of the same gravity crude oil as No. 1, with a well head pressure of 342 lb. This test was later deepened to 6,206 ft. and gave gas production at that depth. It was plugged back and recompleted at 6,016 ft.

The 3 Dukhan was drilled 2½ miles east of No. 1. It was completed in edge water in May 1942. A few weeks later due to the threat of enemy invasion of the area the entire Qatar operations were abandoned and all equipment and materials were removed to other points. The wells were plugged.

Since the ending of the German war preparations have been under way to resume the development program in the field and also to arrange for pipe-line transportation of the crude oil to the water terminal as shown on map. It is anticipated that the initial deliveries through the 10-in. line will be approximately 20,000 bbl. daily. A sea-loading terminal is to be installed.

This program was submitted for approval to Petroleum Administration for War as a war project. It will now become one of the major postwar programs of the Middle East with plans for additional exploration on the peninsula. The Dukhan field in 1944 was rated a 500,000,000-bbl. probable reserve by the De Golyer committee.

Geology

Production of the Dukhan field comes from a Mesozoic limestone formation. The surface reveals a north-south anticline 4½ to 5 miles wide with an indicated length of 50 miles. The structural elevation of the discovery well is 300 ft. The three tests have shown thickness variations in the beds overlying the reservoir which reduce the size of the subsurface structure from 1 Duk-

Current Article Completes Middle East Series

THIS is the final article of a series by the editor of The Oil and Gas Journal dealing with the present and future of petroleum operations in the Middle East. Starting last summer the Journal editor spent 3 months visiting all the major oil-producing areas and refining centers of the Middle East and Near East. He also visited many of the capitals of the oil-producing countries where he interviewed governmental officials. H traveled 20,000 miles by air and trips by tanker and other means of transportation were necessary in order to contact all the operating points.

His survey of the oil areas was followed by several weeks in London and France where he contacted the main offices of companies having Middle East operations. He also obtained from company and governmental officials of European countries first-hand information regarding plans for the rehabilitation of refining and distributing facilities.

This visit furnished the background for the factual series of articles covering every phase of Middle East operations. Additional data including a summary discussion will be published in the Journal's Annual International Number, December 29.

Following is a list of articles published on the Middle East, in addition to the accompanying article:

"Operations Recently Resumed in Kuwait Following Total Shutdown Caused by War," August 18.

"Anglo-Iranian Is World's Largest Single Integrated Operation in the Industry," September 22.

"Five Fields With 51 Wells in Iran Produce Total of 365,000 Bbl. of Crude Daily," October 6.

"Products of Industry's Largest Manufacturing Unit Have Most Widespread Distribution," October 13.

"Bahrein Island Produces 20,000 Bbl. and Refines 70,000 Bbl. Per Day," October 20.

"Bahrein Concession Development Based on Maximum Recovery by Natural Flow," October 27.

"Saudi Arabian Petroleum Operations Are Rapidly Reaching Major Proportions," November 3.

"Construction Program Under Way in Iraq Will Triple Present Crude Output," November 10.

"90,000-Bbl. Haifa Refinery Largest in Mediterranean Area," November 17.

"Egyptian Exploration Is Being Conducted on Broadest Front in History," December 1.

"Only Production in Egypt Comes From Two Fields on Suez Gulf Shores," December 8.

han. A southward and eastward thickening of the formations caused reservoir in both No. 2 to the south and No. 3 to the east to be at lower structural positions. Conditions on the west and north flanks are yet to be determined.

Four limestones of Zekrit formation have been found so far in the Dukhan field. The Nos. 1 and 2 limestones are barren and thin; the No. 3 which is approximately 100 ft. in thickness produced oil in wells Nos. 1 and 2 and water in No. 3. The No. 4 limestone, which is some 330 ft. deeper than No. 1 limestone, produced gas in No. 2 and water in No. 3.

To secure immediate production the management plans to drill in the northern part of the field in order to produce from the No. 3 limestone. In the initial stages the wells will alternate on the west and east flanks at intervals of 3 miles. The first two wells of the field which were plugged in 1942 will be reopened.

Indicative of the operating difficulties inherent in a remote area, three complete drilling rigs will be required in order to keep two rigs in continuous operation. One of the units is rigged up ahead of the completion dates of the other rigs. The rigs, which will have mechanical power, will be capable of drilling 10,000 ft. Sea water is used for circulation. Domestic water has to be imported.

Drilling Practice

The first 1,000 ft. is drilled "blind" in hard, dry, and porous formations. This is cased off and a water string is set around 4,000 ft. The drilling is difficult and it is necessary to have a reserve string against failure. The wells are completed with an 8⅝-in. string cemented on top of the producing horizon. The wells are then drilled and produce from open hole.

Complete gas and oil analyses are made from several bottom-hole samples. From these analyses the method of future operation will be largely determined. The company proposes in the Qatar field to operate the wells with multistage separation. The closed-in well-head pressure is 800 to 850 lb. and each well will be equipped with separator which will operate at 500 lb. The wells will then be connected to a central point where additional separation will take place. Three 93,000-bbl. tanks will be required for working storage in the initial operation. Additions to buildings used as stores, work shops, and living quarters will be necessary. It is expected that it will be well under way by the end of 1946. Final arrangements have not been made as to the disposal of the crude oil which will be available to the four main owners of the operating company: Anglo-Iranian Oil Co., Ltd.; Anglo-Saxon Petroleum Co., Ltd. (Shell); Compagnie Francaise des Petroles, and Near East Development Corp. (Standard Oil Co. (New Jersey) and Socony-Vacuum Oil Co., Inc.

Texans Getting Ready to Fight Oil Agreement

AUSTIN.—Texans opposed to Senate ratification of the revised British-American oil agreement completed plans last week to be represented at the Senate foreign relations committee hearing in Washington January 16.

Railroad Commissioner Beauford H. Jester said he would attend the hearing, mainly to ask questions. Olin Culberson, chairman of the commission, who has been outspoken against the treaty, is likely to appear before the committee. Jester said the commission probably would meet soon to formulate a policy in regard to the treaty.

"There are lots of things about that treaty that I do not know," Jester said. "It may be all right, but I propose to go into it thoroughly and find out for myself. I have been hearing considerable opposition to it from the little fellows in the oil industry."

Equipment Committee Wants Price-Control Ended

WASHINGTON. — Removal of price control on drilling equipment was urged by a newly organized oil drilling equipment industry advisory committee which met last week with Office of Price Administration officals. The group indicated that no general price increase would be requested, although it is possible that some individual firms may seek adjustments.

Members of the committee indicated that further price control would not be necessary, since prices are fairly well stabilized throughout the industry. At OPA's request, the committee will submit financial data of past operations to support its recomendation of decontrol.

Officers of the committee elected at last week's meeting include the following: Chairman, F. J. Spang, president of Spang & Co., Butler, Pa.; vice chairman, A. M. McKinney, president of National Supply Co., Toledo, Ohio; secretary, Karl L. Elliott, treasurer of Acme Fishing Tool Co.

Superior's newly completed fleet in echelon formation immediately prior to departure for Nassau. The radio-equipped boats are 50 ft. long and weigh 21 tons

Seismic Fleet Departs on 1,500 Mile Journey to Bahamas

by E. H. Short, Jr.

HOUSTON.—Recently The Superior Oil Co. dispatched its seismic fleet from Cameron, La., to the Bahama Islands some 1,500 miles away. A little over a year ago, this company won considerable recognition along the Gulf Coast in developing a successful distant offshore seismic-survey technique, so that this water party leaves in its wake a series of successful accomplishments which peculiarly fits it for the important and difficult assignment facing it in the Bahama waters.

Under the name of Bahama Oil Co., The Superior Oil Co. has concessions from the British Government covering approximately 20,000 sq. miles which include portions of the Andros Island and all waters on the Bahama bank west of Andros to the Keys on the east of Florida Straits.

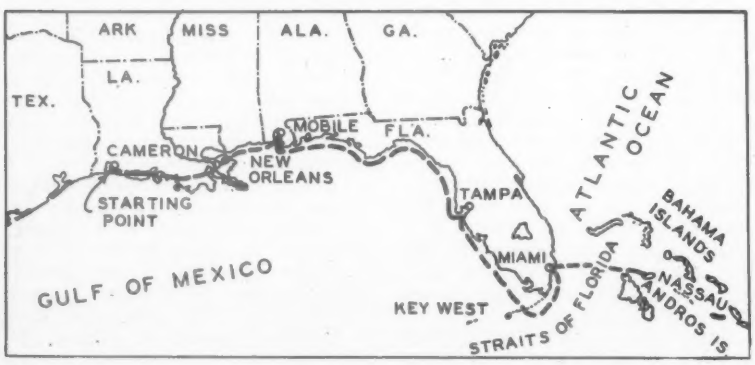
The movement of the Superior seismic fleet will be one of the longest journeys of its kind ever made. From Cameron, the fleet will proceed as far as possible, as shown in the accompanying map, through the Intercoastal Canal. Approximately 12 days will be required to reach Nassau.

R. E. Wilder, left, is chief of party and will be in direct charge of Hahama work. K. G. (Red) McCann, right, is chief geophysicist of Superior, and will accompany and direct fleet from Miami to Nassau

The whole fleet is new and was constructed to Superior specifications. Each boat is over 50 ft. long and weighs 21 tons. Radio equipped, these boats have everything in the way of auxiliary equipment necessary for efficiently conducting water seismic surveys.

While the boats are new the men in the party are seasoned water operators. During the work around the Bahama Islands the party will be completely on its own resources since the nearest town, probably Miami, is some 24 hours away by boat. For this reason the party has been provided with every imaginable item for making living conditions on the boats quite comfortable.

Route of the 1,500-mile journey is indicated by the dotted line. The course follows the Intercoastal Canal to New Orleans, thence around Florida to the sea



Texas Pacific Disposes of Large Texas Properties

FORT WORTH. — Texas Pacific Coal & Oil Co. has sold to Frank Walker, of Ranger, Tex., surface rights on more than 32,000 acres of land in Palo Pinto, Eastland, Erath, and Stephens counties. The consideration is reported to have been slightly under $500,000. The company has oil production on some of the land and it retains about 25,000 acres to the east of the block sold to Walker. The property sold, with Texas Pacific keeping all but the surface rights, has been in the company's ownership 47 years. It is to be sold by Walker in tracts of 1,000 acres or more for ranch and farm purposes.

This was the second major transaction of Texas Pacific within a week, the company having previously sold its marketing properties in Central West Texas to Humble Oil & Refining Co. The sale involved 17 bulk stations, 6 subbulk agencies, 28 service stations and dispensing equipment and storage tanks at 139 other retail outlets operated by contract dealers and similar equipment at an unspecified number of consumer locations.

Welch Chosen President of New Mexico Association

ARTESIA, N. M.—Van S. Welch, of F. W & Y. Oil Co., Artesia, was elected president of New Mexico Oil and Gas Association at its annual meeting here last week. Emery Carper, Carper Drilling Co., Artesia, was chosen vice president; Harry Leonard, Leonard Oil Co., Roswell, treasurer; Hugh L. Sawyers, Roswell, executive secretary. Nevin M. Baird, American Republics Corp., Artesia, and John M. Kelly, geologist, of Roswell, are new members of the executive committee.

The association went on record as approving a bill now in the U.S. Senate which would grant to New Mexico certain public lands for the use and benefit of various public institutions, but recommended that the minerals be included. It approved the Anglo-American oil agreement in its revised form.

Rocky Mountain Group Seeks Liberalized Leasing Laws

by Nell Williams

CASPER, Wyo.—Proposed legislation seeking to liberalize present federal laws governing the leasing, exploration, and production of petroleum and natural gas on the public domain occupied the major attention of the Rocky Mountain Oil and Gas Association at its annual membership meeting here December 7 and 8. The general program was highlighted by an address on Peace Time Petroleum Products by Dr. Gustav Egloff, Universal Oil Products Co., Chicago, who stated, among other things, that the oil industry has the sources of supply and the "know how" to produce the gasolines needed to meet the country's requirements for centuries to come.

Resolutions directed to Harold Ickes, Secretary of the Department of the Interior, urging that the department, in its forthcoming reports on new public-land leasing bills (SB 1236 and HB 3711) which are now before Congress, give consideration to certain recommendations for amendments desired by the oil industry.

The proposed amendments to SB 1236 now being sought by the industry were discussed at length by A. C. Mattei, president of Honolulu Oil Co., San Francisco, and member of the subcommittee of the National Oil Policy Committee of Petroleum Industry War Council, which has worked with the Interior Department on the leasing act. He presented a report on the progress made by the committee in its efforts to attain revision of the public-land leasing legislation. He declared that an interbureau controversy and rivalry which had developed in the Department of Interior, has delayed the department's report on the proposed new legislation.

The present differences in the department, Mattei said, are between division heads who are not familiar with the public-land exploration and development problems. The only solution, he continued, is to get men in the department who know and are sympathetic with these problems.

Recommendation of the industry for amendments to the proposed public-lands leasing legislation as outlined by Mattei and also by H. H. Healy, division manager, Ohio Oil Co., Casper, and chairman of the legal and legislative committee, include the following provisions:

1. Establishment of a flat 12½ per cent royalty on all leases heretofore and hereafter issued which are not on proved oil or gas structures.

2. Reduction of the royalty to 12½ per cent on leases on all structures which have been proved productive since the effective date of the war emergency, May 27, 1941.

3. Deny the right of the Department of the Interior to set the value of royalty on oil, gas, or gasoline.

4. Permit free right for assignment of public land leases without the consent of the Secretary of the Interior, provided government interests are amply protected.

5. Permit options for geological and geophysical exploration without limitations on the amount of acreage, provided options do not run more than 2 years.

6. Increase the limitations on amount of public-domain leases which can be held by individual companies on any structure.

7. Adoption of new regulations under the act which will be realistic in protecting both the interests of the Government and the operators.

Mattei recommended that the industry be reasonable in asking for increases in acreage limitations for geophysical and geological options and not try to have the limitations set at such a high figure that would scare off revised legislation. What is wanted, he said, is an act that will encourage development, insure freedom of operation, and keep the Government out of the oil business as much as possible.

Concensus of the group was that all government-owned lands, in addition to those at present classed as public domain and administered by the Department of Interior, should be brought under the new public-land leasing act, and handled through a single agency.

Paul Stock, Cody, Wyo., in his presidential address, expressed the keynote of the convention when he declared that the association must continue the fight for "correction of government leasing laws affecting public domain, and elimination of certain abuses in restriction of exploration and development." He said that the oil industry, if freed from its present restrictions, can produce enough oil from public-domain lands to supply all the country's petroleum needs.

O'Mahoney Heard via Transcription

Sen. Joseph C. O'Mahoney of Wyoming, chairman of the special committee investigating petroleum resources, and coauthor of the new public-lands leasing bill in the Senate, in a transcribed address directed to the association and heard by radio at the convention, declared that it is essential that the federal Government adopt a policy in its attitude toward exploration of the public domain that will keep the small wildcatter in business. He expressed the opinion that "enactment of the bill will afford a real opportunity for expansion of the petroleum industry in the public-land states and, particularly, an opportunity for the expansion of exploratory work."

He pointed to the present need for finding and developing new reserves, and expressed the opinion that the western states, in which are located most of the public domain, offer unlimited opportunity for exploration and development of new sources of oil. For this reason, he said, revision of the present oil and gas leasing act as a means of encouraging development on public domain is a project of greatest importance.

Paul Stock, independent operator, Cody, was reelected president of the association for the ensuing year. James Donoghue, Mackinnie Oil & Drilling Co., Denver, was reelected first vice president; Fred Goodstein, Trigood Oil Co., Casper, second vice president for Wyoming; R. B. Curran, Carter Oil Co., Billings, second vice president for Montana; Gilbert J. Mueller, Argo Oil Co., Denver, treasurer, and H. O. English, Casper, executive secretary.

E. J. Sullivan, president of E. T. Williams Oil Co., and C. B. Richardson, president, Consolidated Royalty Oil Co., Casper, were awarded honorary life memberships in the association. Both are pioneer operators in the Rocky Mountain area and have been active in organizational work in the area since the original association was formed in 1921.

Dr. Egloff discussed the developments in technology for production of high-octane gasoline. Cars on the road today do not need and cannot use the ultrahigh-octane gasolines which the oil industry is capable of and has been producing during the war, he pointed out. However, he

asserted, the industry has the capacity for production and the quality of motor fuel is now available for the time when the automobile industry can get busy and produce the cars to take advantage of it. At present, he said, the industry in its ability to produce quality motor fuel is far ahead of the automobile industry in its building of engines to use it.

He pictured the time when automobile engines with weights reduced to as low as 2 lb. per horsepower would be developed to use the higher-octane gasolines. Naturally, he said, the price of motor fuel to the consumer will have to go up some, but increased efficiencies, if properly utilized, will compensate for the greater cost.

Industry Has the Know How

It was in discussing the potentialities in the use of liquefied gas that Dr. Egloff stated the oil industry has the sources of supply and the "know how" to meet all gasoline needs for centuries to come. There are extensive sources of gases from which quality fuels can be produced, he said. He pointed to the excess gases produced by present refining processes as one source. Also, there are large quantities of butanes and propanes, as well as methanes and ethanes, in natural gases which are available. He discussed the potentialities and developments in use of methane and ethane, and possibilities of use of coke-oven and coal gases. He explained, however, that the production of gasoline from coal gases is expensive, about 12 cents per gallon, and will not displace gasoline from petroleum for the time being.

He discounted the competition of ethyl alcohol from grain as a fuel. Although a productive capacity of more than 550,000,000 gal. of ethyl alcohol daily has been built up during the war, the cost of this fuel is about 30 cents a gallon, and its manufacture is about five times as hard as that of 75-octane gasoline from petroleum, he explained. Only where economics does not play a role will this product be a factor.

Dr. Egloff also stated that synthetic rubbers are now being developed from petroleum products that are far superior in every way to natural rubber, and that under competition the price should drop as low as 10 cents per pound. He predicted that within a few years synthetic rubber tires would be produced that would outwear cars, and that all tires would be from this product.

Thomas S. Harrison, consulting geologist, Denver, in his address on "The Oil Record Within the Rocky Mountains," traced the development of oil reserves in the district and the part played by modern scientific methods of exploration and development. He predicted that proved, drilled and undrilled reserves in the Rocky Mountains will exceed by a substantial margin the amount produced to date. As a result of war-period development, he said, the present-day calculated reserve is larger by many millions of barrels than that existing at the beginning of the war.

Standing Committees

Chairmen of standing committees for 1946 are:

Legal and legislative, H. H. Healy, division manager, The Ohio Oil Co., Casper; vice chairmen, Harry Chapman for Montana, The Carter Oil Co., Billings; E. J. Sullivan for Wyoming, E. T. Williams Oil Co., Casper; Gilbert J. Mueller for Colorado, The Argo Oil Corp., Denver.

Public lands, Glenn Nielson, Husky Refining Co., Cody.

Production, Carroll Kirk, Kirk Oil Co., Frannie, Wyo.

Taxation, J. F. Cullen, division manager, Stanolind Oil & Gas Co., Casper.

Public relations, H. P. Macauley, division landman, Continental Oil Co., Denver.

Finance, Gilbert J. Mueller, vice president, The Argo Oil Corp., Denver.

Natural gas, J. M. McIntire, president, The Northern Utilities Co., Casper.

Shell Returns to 40-Hour Week in Texas-Gulf Area

HOUSTON. — All operations of Shell Oil Co., Inc., in the Texas-Gulf production area which before the war were on a weekly schedule of 40 hours or less have returned to the 40-hour week.

Simultaneously with this action, hourly rates and basic monthly salaries are increased as follows: Employes earning up to $300 a month and paid by the hour or month, 15 per cent; monthly-paid employes earning $301 to $450 a month, $45 a month; monthly-paid employes earning $451 to $650 a month, 10 per cent, except that no salary is to be projected above $650.

Shell's Texas-Gulf production area includes Texas, Arkansas, New Mexico, Louisiana, and the southeastern Gulf Coast states.

Wartime Tanker Job Covered 525 Vessels

WASHINGTON. — The wartime tanker building program, which produced 525 tankers of the T2-SE-A1 type or modifications, came to an end in November with the delivery of the SS J. H. MacGaregill by the Sun Shipbuilding and Dry Dock Co., Chester, Pa., the Maritime Commission announced last week.

The first tanker of the type was the Esso Gettysburg, delivered by the same company on February 28, 1942. Of the total tankers produced, the Sun yard turned out 198; Alabama Dry Dock and Shipbuilding Co., Mobile, Ala., 102; the Kaiser Co., Inc., Swan Island Yard, Portland, Ore., 147; and Marinship Corp., Sausalito, Calif., 78.

Of 42 ships of various types delivered to the Maritime Commission in November of this year, five were standard tankers, and five coastal tankers. Deliveries included: Bethlehem-Sparrows Point Shipyard, Inc., Sparrows Point, Md., one T9-3-tanker; J. A. Jones Construction Co., Inc., Panama City, Fla., two T1-coastal tankers; Sun company, two T2-tankers, and Todd-Houston Shipbuilding Corp., Houston, Tex., three T1-coastal tankers.

DEATHS

Samuel Lloyd Davis, 49, treasurer of the United Gas Corp., in Shreveport, died in that city December 7.

Albert L. Shaner, 80, executive of many oil companies, died December 6 in Bolivar, N. Y. He was president of Richburg Supply Co. and the Davis Oil Co., and was a member of the board of directors of Messer Oil Co.

Fred S. Wilson, 77, active in the oil and gas business, died December 1 in Chanute, Kans.

Claude W. Hanley, 63, who recently retired as zone agent for Gulf Oil Corp. in North Texas, died December 4 in Fort Worth. He had been in Gulf's service 28 years.

Paul M. Gregg, 70, former vice president and chief counsel of Union Oil Co. of California, died December 2 in Pasadena. In recognition of his service from 1922 to 1940 Union named its largest tanker after him before his retirement.

John F. Burke, who was secretary-treasurer of the old Burke-Greis Oil Co., Tulsa, died last week in Buffalo, N. Y.

C. W. Hanley, retired North Texas zone agent for Gulf Oil Corp., died December 4 in Fort Worth, where he had lived and headquartered for the past several years. He had been employed by Gulf for 28 years, moving to Fort Worth when North Texas offices were transferred from Wichita Falls.

W. A. Bergan, 53, Middle West representative for Calumet Refining Co. for 18 years, died December 7 at Indianapolis.

FACTS YOU SHOULD KNOW ABOUT U.O.P.

The service that Universal Oil Products Company offers is so broad in scope that not everyone realizes its extent and the importance of each of its activities.

Top management may think of us only as the originators and licensors of its refining processes. Engineers may tell you that we design refinery equipment. Operators and maintenance men may know us primarily as a servicing and inspection organization. The fact is, we're all of these . . . and more. Here, in brief, is a resumé of the services which UOP offers to the Petroleum Industry.

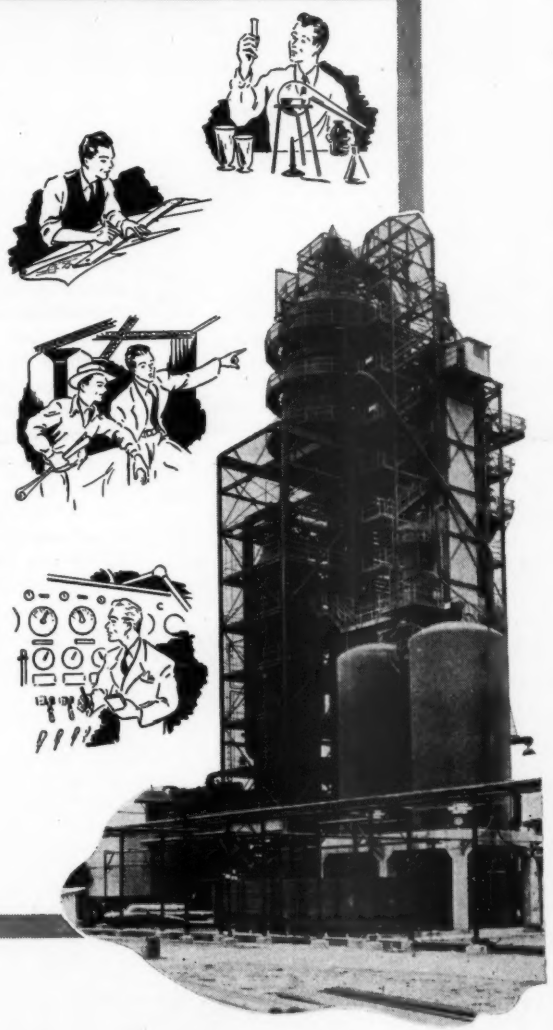
PROCESSES: We are constantly engaged in research and experimentation to improve the processes of petroleum refining. Universal scientists have been responsible for many of the major improvements in modern refining processes including thermal cracking, catalytic cracking, polymerization, alkylation, isomerization, hydrogenation, dehydrogenation, and others. The processes which we develop are available to all refiners.

ENGINEERING: In order to assure proper results from the processes which we develop, we assume full responsibility for the design of all necessary equipment.

SUPERVISION: While we do no construction ourselves, we do provide competent engineers who devote their time to careful inspection of the construction and erection of the equipment which we design.

SERVICING: Once the plant is on stream, one of our most important activities . . . Servicing . . . starts operation. This includes, first, an intensive training program to impart to operating men an exact knowledge of the operation of the new equipment. Second, we send expert operating men periodically to the licensee's refinery to check yield and render counsel and advice. Third, we maintain a most efficient inspection organization composed of specially trained men who are continually in the field making physical inspection of licensed units and recommending such steps as may be necessary to insure continued high efficiency.

Thus, not only does Universal provide the original process and live with the job until it is on stream, but continues to maintain a lifetime interest in its efficient, economical operation.



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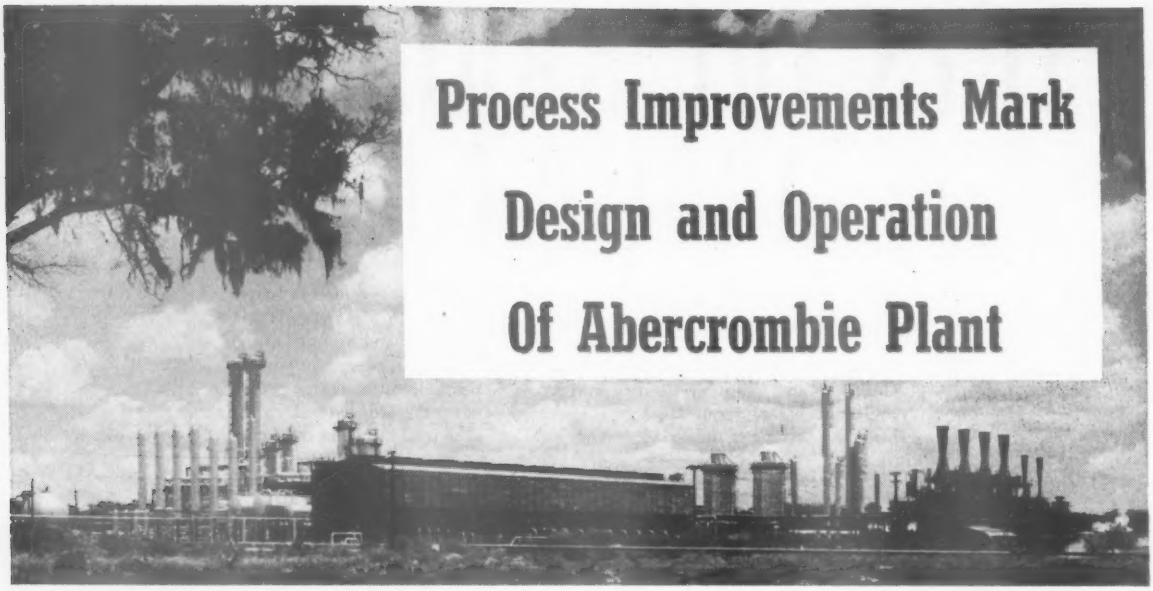


Process Improvements Mark Design and Operation Of Abercrombie Plant

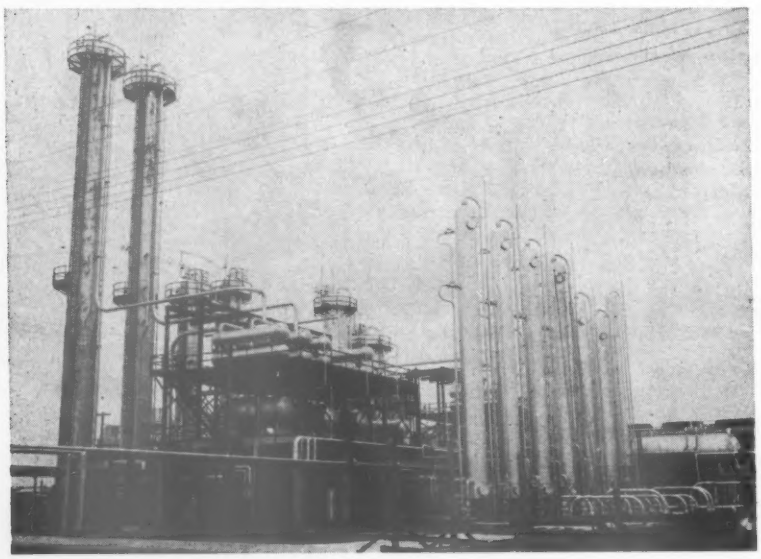
Over-all view of the Abercrombie and Magnolia Petroleum Co. plant, Old Ocean, Texas

Installation of a pressure-maintenance plant at Old Ocean field, near Houston, made it necessary to enlarge greatly the light gasoline and other liquid products produced in the operation. Five gas streams at five different pressures are treated by extracting liquid products in seven absorbers. Absorber oil progresses from higher to lower pressures in the system; all pentanes and heavier and practically all butanes are recovered.

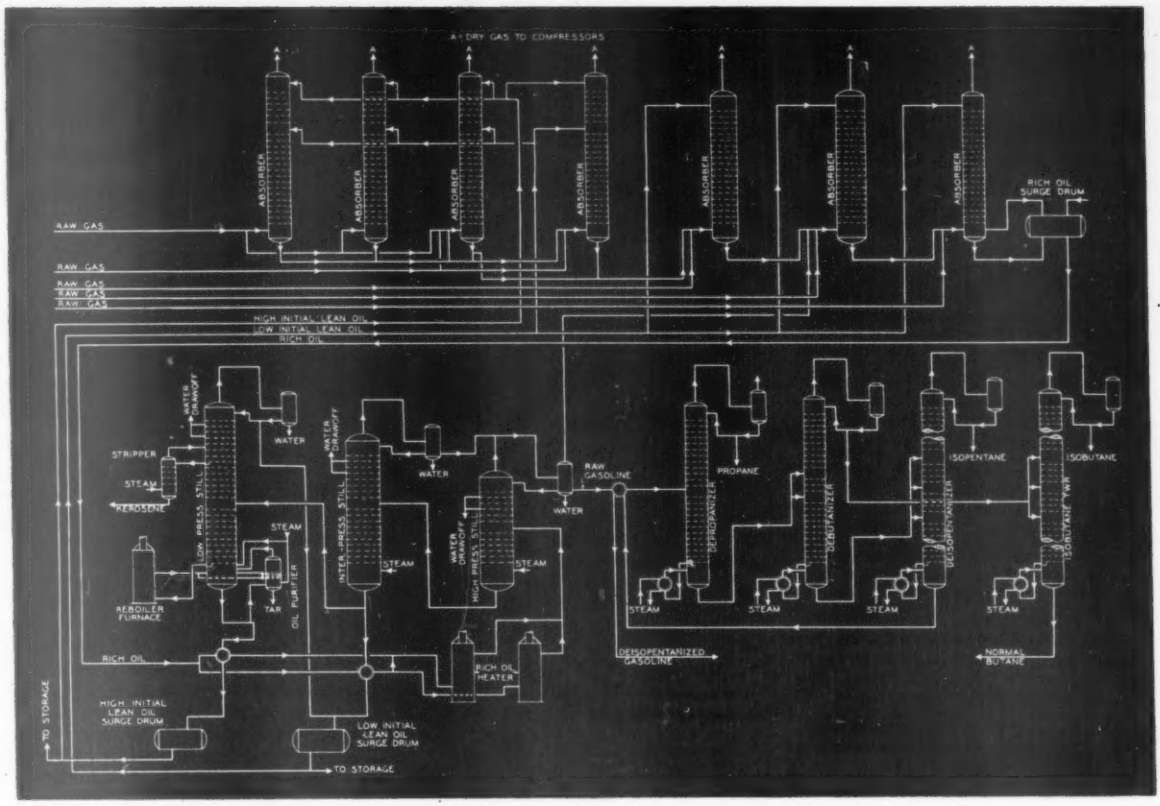
PROCESSING 350 million cubic feet of rich gas per day is not unknown to the refining and natural-gasoline industries, but is no mean feat, as is well known to J. S. Abercrombie Co. in its operation on the Old Ocean field 60-odd miles below Houston. Situated just a few miles back from the Mexican Gulf shore the plant has the various advantages and disadvantages of the low-lying, alluvial coastal plain region and its proximity to ocean terminals and shipping facilities.

Faced with the desirability of maintaining pressure on the Old Ocean field to improve crude recovery and to increase the ultimate recovery obtainable from the field, the Abercrombie and the Magnolia Petroleum Co. interests, joint owners of the field, decided to install a pressure-maintenance unit, including a recovery plant to segregate the light oil and natural gasoline produced with the gas processed. The field has five producing horizons and it was obvious, therefore, that the pressure-maintaining system must be relatively complicated, thus involving some complications in the design and operation of the plant. Preliminary investigations showed the pressure levels which should be maintained in the different horizons and the approximate amount of gas which should be handled, and the recovery plant was designed and built on the basis of these quantities by J. F. Pritchard & Co. under the supervision of H. M. Nelly, Jr., head of Pritchard's oil division.

The plant is arranged to handle five streams of gas continuously at the fllowing pressures: 1,800-2,250 psi.; 1,250 psi.; 500 psi.; 150 psi., and 50 psi., all gage pressures. The gas circuits are independent of each other, with a unique arrangement for the combined operations, as will be shown when discussing detailed operations. The highest pressure assembly is designed for 2,250 psi. top pressure but is now operated at about 1,800 psi. Seven absorbers handle the five gas streams. Three are designed for 2,250 psi. as stated but may also be operated at 1,250 psi. if and when desired to place more capacity in that stream. One absorber each is installed for the other four pressures. The three 2,250-lb. absorbers are 4-ft. diame-



Isobutane and isopentane towers, left; absorbers, right; overhead condensers and reflux drum, center, in Abercrombie's Old Ocean plant



Flow chart of the recovery plant

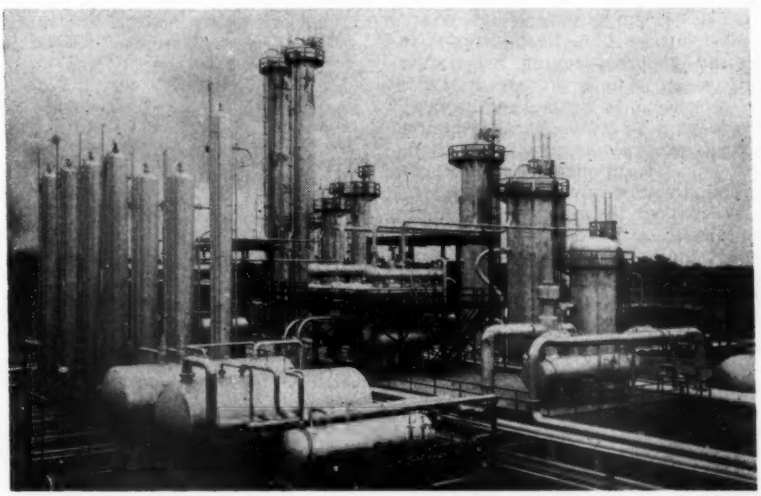
ter by 60½ ft. high, fitted with 22 trays. The 1,250-lb. absorber is also fitted with 22 trays but is 5 ft. diameter by 60½ ft. high. The other three absorbers have 20 trays each, that for 500-lb. operation being 5 ft. by 55½ ft.; for 150-lb. work 5½ ft. by 53½ ft.; for 50-lb. operations, 4 ft. by 54 ft. Between the absorber battery and the stills is placed a rich oil surge drum which is 11 ft. by 28 ft. long.

Three still units are provided. The low-pressure still is 8 ft. by 67½ ft., operates at about 5 psig. It is fitted with 24 trays, from the lowest of which the oil is drawn to a reboiler furnace for final stripping, the hot oil returning to the base of the tower below the trays. An intermediate oil stripper is also included in the list of tower accessories, it being 4 ft. by 16 ft. with four trays, steam heated. Part of the lean oil is purified in a tar still connected with the tower's base. The intermediate pressure still is a 12 by 56¼-ft. tower with 18 trays, designed to operate at about 50 psig. The high-pressure still operates at around 185 psig., is 11 by 38⅛ ft., with only 12 trays. Each tower is equipped with a separate condenser and accumulator assembly. Two Petrochem rich-oil heaters bring the rich oil to the required temperature before it reaches the high-pressure tower. Pumps used in the plant are mainly Ingersoll-Rand and Pacific.

The fractionator assembly is made up of four towers with reboilers, condensers, accumulators, etc. No. 1 tower is a depropanizer 5 by 65½ ft., 24 trays. Second tower is 5½ by 61 ft., with 24 trays, for debutanizing the raw stock from the depropanizer. The deisopentanizer is 7 by 117 ft., with 50 trays. The deisobutanizer tower is also 7 by 117 ft. with 50 trays. These two last towers have a difficult job to carry through, separating relatively pure isoparaffins from general mixtures, therefore they are provided with a greater number of trays.

Operation of Plant

As before stated, five separate streams of gas each at a different pressure are led into the plant. The highest pressure gas, now at about

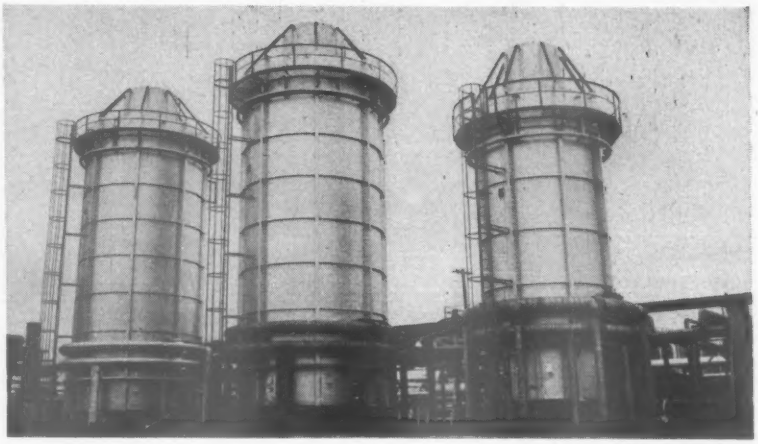


Absorbers at left, fractionators in center, stills at right

1,800 psig. but which may be introduced up to 2,250 psig., is brought in at about 140 million cubic feet per day, to the two 2,250-lb. absorbers referred to above. A third absorber may be operated at either 2,250 or at 1,250 psig. as the relative amounts of gas at the two pressures may require. In these absorbers a unique system for the absorption medium is employed. A low-initial-boiling-point lean oil that is, an oil relatively high in volatility and also high in absorptive capacity, is introduced into the tower at about the seventh tray, and of course travels downward to the tower bottom. A high-initial-boiling-point oil is introduced at the tower top and continues downward, mingling with the lighter oil entering on the seventh tray. The purpose of this is to obtain the high absorptive capacity of the lighter oil and also to avoid the loss of light ends of absorption oil which would follow from introducing the lighter oil at the tower top. This type of operation is considered one of the important innovations employed in this plant, and accounts in good part for the high hydrocarbon recovery attained. The two streams of light and heavy oil mingle and are processed as one stream. Later, in the oil distillation unit, a portion of the lean oil is topped to make up the high initial point oil going to the tower tops. This double oil stream plan is also used in the 1,250-lb. tower.

Similarly in turn the streams of gas at each of the four lower pressures enter their respective towers. Low initial lean oil is admitted near the top of each tower, meeting the ascending gases in the conventional manner. Pressure vessels in this unit were made by A. O. Smith, Chicago Bridge & Iron, and Wyatt.

And here is introduced another innovation, one which appears to show excellent returns. The fat oil from each tower in turn, as shown in the accompanying flow chart, does not pass to a flash drum, nor do the vapors escaping from such a drum pass to a reabsorber. Each fat oil stream is flashed in the next tower in the series, operated at the next lower pressure. By this method, the vapors from each oil stream, released by the pressure reduction, pass upward through the tower in contact with the oil passing downward through that tower, giving what doubtless is a thorough stripping action, further improving the total recovery with less equipment and fewer operations. Combined stripped vapor streams from the tower tops go direct to Cooper-Bessemer pressure maintenance compressors to be boosted to 3,700 psig. for return to the field. The operation of the older plant built here earlier is carried on at the same time but will not be discussed here except to note that its rich oil, at 500 psig., is introduced into the flash and surge drum part of this system and is processed further along with the rich oil of the new plant.



Petrochem rich-oil heaters for Old Ocean plant

From the surge drum the rich oil, held there at 50 psig., is pumped in parallel streams to the two rich oil heaters, raised to 435° F., and passed to the high-pressure still at 185 psig., the parallel streams uniting and entering the tower midway of the 12 trays. The condenser accumulator is maintained under the same pressure to hold the product as it is condensed until transferred to the fractionation unit. The partially stripped oil is transferred from this tower bottom to just above the middle of the intermediate pressure tower and flashed therein to about 50 psig., normally at about 425° F. Another portion of the absorption gasoline is flashed off here and passed overhead, holding about 230° F. tower top, condensed and held in the accumulator at tower pressure. Part of this twice-flashed oil is transferred to the low pressure still at around 390° F. and is flashed down to 5 psig. about midway of that tower. With a top temperature of about 240° F., the heaviest absorber material is driven off overhead and to a condenser at essentially atmospheric pressure. This tower uses a furnace as reboiler.

At this point the method for adjusting and purifying the absorption oil warrants attention. From the base of the intermediate pressure still a portion of the partially stripped oil is drawn off without going to the third or low pressure still and without treatment is storaged and returns to the low initial lean oil system. The remainder of this stream enters the low pressure tower as mentioned above. The lean oil in the bottom of the low-pressure tower is purified; in a side purifica-

(Continued on page 123)

TABLE 1—FEED GAS QUANTITY AND ANALYSIS

Pressure (psi. gage)	2,250	1,250	500	150	50	Vac.
Volume (MM cu. ft./D)	207	100	12	20	4	3
Analysis (Mol %)—						
Methane	90.83	91.27	91.81	89.33	68.51	56.43
Ethane	5.04	4.96	4.50	5.52	13.73	8.90
Propane	1.90	1.80	1.86	2.46	10.20	15.35
Isobutane	0.52	0.43	0.50	0.59	2.21	6.48
Nor. Butane	0.57	0.57	0.52	0.60	2.52	5.60
Isopentane	0.18	0.18	0.20	0.36	1.00	3.76
Nor. Pentane	0.20	0.19	0.21	0.23	0.63	1.98
Hexane Plus	0.78	0.60	0.39	0.91	1.20	1.50
Total	100.00	100.00	100.00	100.00	100.00	100.00
Gal./M cu. ft.	0.807	0.700	0.636	0.969	5.598	6.570
Sp Cr. of C_6	0.739	0.739	0.739	0.739	0.739	0.739

TABLE 2—DRY GAS ANALYSIS

Analysis (Mol %)—	1,800 psi. Dry gas	1,250 psi. Dry gas	500 psi. Dry gas	150 psi. Dry gas	50 psi. Dry gas
Methane	94.46	94.65	92.85	87.51	63.79
Ethane	3.96	4.30	5.68	9.24	20.85
Propane	1.40	0.90	1.33	2.95	13.52
Isobutane	0.11	0.09	0.09	0.20	1.30
Nor. Butane	0.07	0.06	0.05	0.10	0.54
Isopentane	.....	.....	.....	.....	.....
Nor. Pentane	.....	.....	.....	.....	.....
Hexane	.....	.....	.....	.....	.....
Total	100.00	100.00	100.00	100.00	100.00

Measuring Distribution of Liquids in Flowstring of a Gas-Condensate Well

*by C. K. Eilerts, R. V. Smith, and V. L. Barr**

THE Bureau of Mines, in cooperation with the Natural Gasoline Association of America and the American Gas Association, is investigating means of preventing the serious corrosion[1] to which some high-pressure, gas-condensate wells in the Gulf Coast area are subject. Substances in the fluid from these wells are being studied in the laboratory to ascertain the nature of the corrosion and to find inhibitors that will minimize its effects. Alloys are being compared as to composition, fabrication, and resistance to corrosion for the purpose of finding economically feasible materials for making equipment to be used on the wells. Water has an important role in gas-condensate well corrosion, and portable equipment has been constructed and used in the field to measure the distribution of water in the tubing of a flowing well. The amount of water present at a given point in the flow string is significant because it may control rates of corrosion and also determine the effectiveness of inhibitors.

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R. V. SMITH

V. L. BARR

C. Kenneth Eilerts was graduated from Oklahoma A. & M. College in 1927 and entered the petroleum and natural gas division of the Bureau of Mines in 1930. His experimental work in the bureau has been in the polymerization of natural gas, the energy relations of petroleum reservoir fluids, the compressibilities of natural gas and gas-condensate systems, the two-phase and single-phase relations of gas-condensate fluids and recently the protection of gas-condensate wells against corrosion. He has been active in association committee work related to petroleum research problems. His careful analyses of the physical characteristics of reservoir fluids and his appreciation of the phenomena of reservoir behavior are recognized throughout the industry.

R. Vincent Smith was graduated from the University of Missouri in 1934, and received an M.A. degree from the same institution in 1935 for major work in physical chemistry. He entered the service of the petroleum and natural gas division of the Bureau of Mines, Bartlesville, Okla., in 1936. His work as a physical chemist has been in oil-production research and has involved studies of well performance and the determination of properties of fluids from petroleum reservoirs including those of the gas-condensate type.

Virgil L. Barr entered the valuation department of the Cities Service Gas Co. from Oklahoma A & M College in 1939. He was employed by the Bureau of Mines in 1943 and since then has been a member of the Bartlesville group specializing in studies pertaining to the determination of reserves of aviation gasoline components in selected gas-condensate reservoirs of the Gulf Coast area.

Equipment

The mobile laboratory housing the equipment[2] used in measuring the water in the fluid from gas-condensate reservoirs and the operating crew are shown in Fig. 1. Much of the special apparatus used for determining the properties of gas-condensate fluids is mounted in a special 19-ft. body on a 2½-ton truck chassis. A separator or accumulator for measuring liquid-gas ratios, a pump for raising fluid pressures within the accumulator above well-head pressures, and a fractionating column for determining composition of the phases prepared in the accumulator constitute the principal items of portable equipment contained in the truck. A boiler to provide steam for maintaining oil baths at elevated temperatures and an engine and generators housed in fire-resistant compartments within the truck body supply power and electricity for making the tests.

The space inside the truck body where the experimental work is done is 7½ ft. wide, 15 ft. long and 7 ft. high. An interior view of the operating compartment (forward end) is shown in Fig. 2. An instrument panel for the electrical equipment and a manifold of gas-pressure regulators appear in the left background. The steam boiler and 12-hp. gas engine are mounted in separate and closed compartments behind the door to the right of the panel. A corner of the steam-heated oil bath, in which phase (gas and liquid) separating and measuring equipment is mounted, and the piston gage used in the automatic control of operating pressures are shown in the right foreground. Behind the piston gage and under the expanded metal guard is the two-cylinder, high-presssure pump for increasing the pressure on fluid samples continuously withdrawn from the flowing well under test. Over the expanded metal guard is a low-volumetric-capacity, high-pressure pump used for adding water to the fluid sample before it

*U. S. Bureau of Mines Petroleum Experiment Station, Bartlesville, Okla. Article published by permission of the Director, Bureau of Mines, Department of the Interior.

Fig. 1—Mobile laboratory and operating crew

enters the measuring equipment mounted in the bath.

Fig. 3. is an interior view of the rear end of the operating compartment. The driving mechanism of the high-pressure water pump and a high-pressure window used for observing pumping rates appear on top of the expanded metal guard. In the rear of the body is the oil bath in which the accumulator—equivalent in function to a full-scale oil and gas separator—is mounted. Over the oil bath is the instrument panel with the diaphragm and solenoid valves used for controlling temperatures in the three compartments of the oil bath.

A schematic assembly of the portable equipment for testing fluids flowing from gas-condensate wells is given in Fig. 4. Except as to sizes the assembly is similar to the full-scale equipment used in operating gas-condensate wells in that it includes a flow line (2) from the well-head, a flow-rate control valve (7), a high-pressure accumulator (9), a back-pressure regulating valve (20), a low-pressure accumulator (22), and a gas meter (23). The test equipment is constructed to be used on wells flowing through surface equipment from which 1 per cent or less of the flow stream is diverted for testing in the portable equipment by means of sampling nozzle (1) installed in the well head or at other suitable sampling points.

Well-Head Samples Must Be Accurately Taken

When the test equipment is operated at the pressure and temperature of the field separator, it is important that the liquid-gas ratio of the fluid in the high-pressure accumulator be the same as the liquid-gas ratio measured simultaneously with the full-scale equipment. The rate of flow of fluid through the sampling nozzle found to provide a liquid-gas ratio in the portable equipment identical with the liquid-gas ratio in the field separator operating at the same pressure and temperature is the flow rate maintained during subsequent tests at other accumulator pressures and temperatures. The rate at which the well fluid is allowed to flow through the test equipment is controlled by throttling valve (7) or, when pump (4) is used, by adjusting the length of the piston stroke. The rate of flow is indicated by critical flow meter (23) designed for operating at pressures up to 1,000 psi.

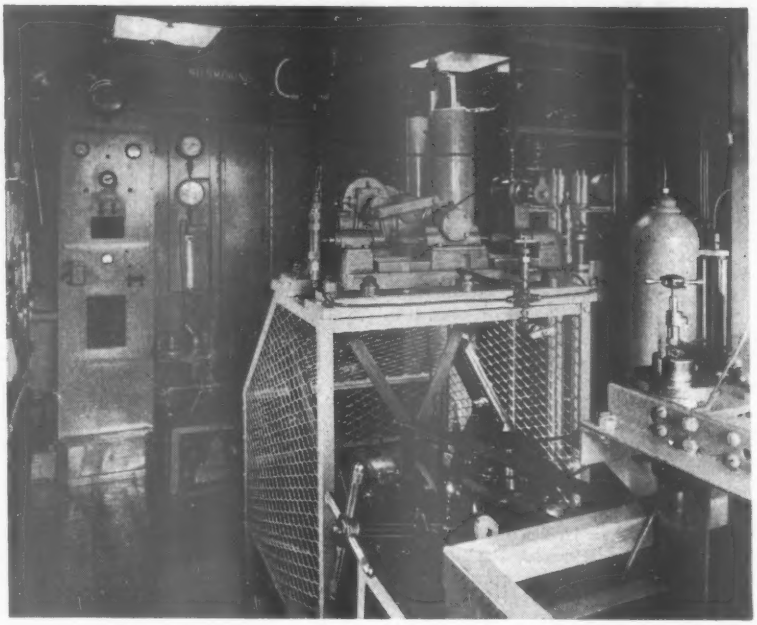


Fig. 2—Equipment in forward end of operating compartment

Liquid-gas ratios at greater than well-head pressures are obtained with the aid of pump (4); the sample of fluid from the well head enters the pump at approximately well-head pressure and is compressed to higher pressures as required in accumulator (9). Pump (4) has two ⅝-in.-diameter pistons and displaces 2.1 cu. ft. of fluid per hour under a pressure of 7,200 psi. and 3.3 cu. ft. per hour under a pressure of 4,600 psi. The pump will provide a flow rate of 700 cu. ft. of gas per hour through the portable equipment in tests on gas-condensate wells having well-head pressures above 4,000 psi. The capacity of the pump is proportionately less if the fluid from the well head enters the pump at lower pressures.

Fluid continuously withdrawn from the well head by means of a sampling nozzle in such manner that it will accurately represent the flowing fluid as to hydrocarbon content has been found to contain a lower proportion of water than operation of the full-scale equipment shows is produced by the well. Injecting pump (28) is used to add water to the fluid coming from the well head through the sampling nozzle so that the sample will be representative of the flowing fluid as to water content also. Pump (28) has two ¼-in.-diameter pistons and will inject water into the sample stream against pressures up to 7,200 psi. at rates variable within the

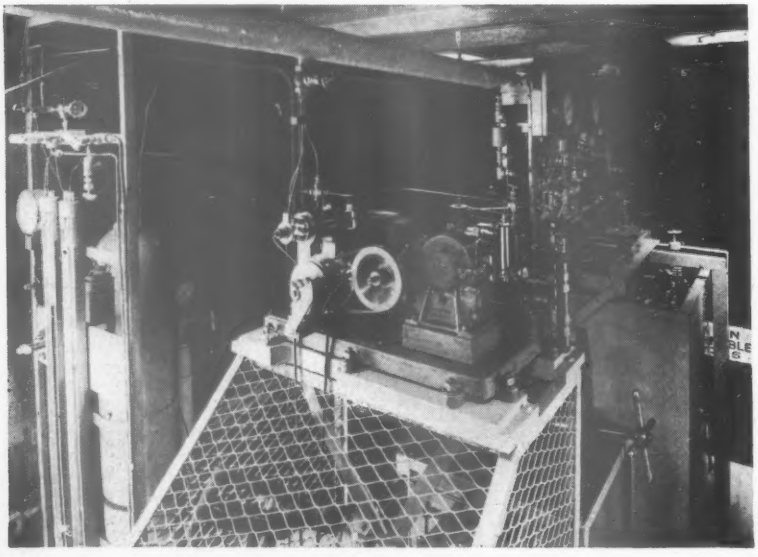
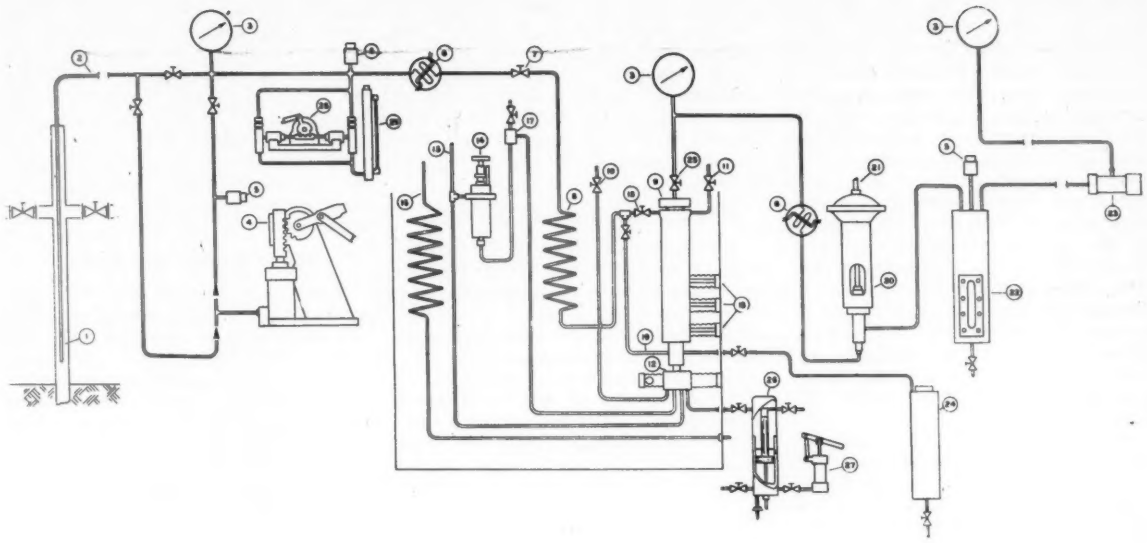


Fig. 3—Equipment in rear end of operating compartment



1. SAMPLING NOZZLE
2. TUBING CONNECTION, WELL TO TRUCK
3. PRESSURE GAGE
4. MOTOR DRIVEN FLUID PUMP, CAPACITY 7,200 PSI.
5. DIAPRAGM SAFETY HEAD
6. HEAT INTERCHANGER
7. FLOW RATE CONTROL VALVE
8. TEMPERATURE STABILIZATION COIL
9. HIGH PRESSURE ACCUMULATOR
10. LIQUID DISCHARGE VALVE
11. GAS SAMPLING OUTLET
12. GLASS WINDOW FOR HIGH PRESSURES
13. LIQUID MENISCUS INDICATING VALVES
14. LIQUID VOLUME METER
15. PISTON GAGE CONNECTION
16. STEAM COIL FOR BATH TEMPERATURE CONTROL
17. MERCURY TRAP
18. VALVE
19. FLUID INJECTOR CONNECTION
20. BACK PRESSURE REGULATING VALVE
21. CONNECTION TO PISTON GAGE PILOT VALVE
22. LOW PRESSURE ACCUMULATOR WITH GAGE GLASS
23. CRITICAL FLOW GAS METER
24. LIQUID STABILIZER
25. THROTTLING VALVE
26. CYLINDER AND PISTON METER
27. PUMP
28. WATER INJECTING PUMP
29. GRADUATED RESERVOIR

Fig. 4—Schematic assembly of portable equipment for testing fluid flowing from gas-condensate wells

range 0.000,7 to 0.003,3 cu. ft. per hour (19 to 95 cc. per hour). Each cylinder is equipped with three inlet and three outlet cone check valves to assure steady performance at these low pumping rates.

Measurement of the Liquid Phases

Accumulator (9) is designed to separate the phases of flowing fluid at constant temperature and pressure and to serve as a reservoir where definite volumes of the liquid phase may accumulate. The fluid enters the accumulator through an opening in the side near the top and moves downward through baffles arranged to cause continuous drainage of the liquid ito the measuring compartment at the bottom of the accumulator. The gas moves upward through a central passage in the accumulator and on through back-pressure-regulating valve (20). When condensate is being collected in the accumulator for measurement one of the liquid meniscus valves (13) is opened. The transparent jet of gas which escapes from the valve while the liquid level is rising to the position of the valve location becomes a white spray when liquid is ejected through the valve with gas. The time interval for the accumulation of liquid between indicating valves is accurately measured.

The separation of the phases af a gas-condensate fluid at reservoir pressure, or at pressures near the dew point where liquid-gas ratios are delatively low, involves slow rates of accumulation. If the liquid-meniscus indicating valves are used under these circumstances excessively long periods of time are required to measure the accumulated liquid. Consequently, glass-window assembly (12) is used to measure low rates of liquid accumulation—either water or hydrocarbon condensate—and to observe phenomena that cannot be studied in any other way. The assembly is made up of two windows, one in either end of a hollow steel cylinder connected to the bottom of the accumulator, and when one window is illuminated the material in the cylinder may be observed through the opposite window by means of a mirror which reflects the light in a direction at right angles to the axis of the cylinder. The window assembly has been tested at a pressure of 10,000 psi. and has been used at temperatures up to 280° F.; the windows have withstood the service required without breakage or leakage of gas-condensate fluids.

Cylinder and piston meter (26) is used with the window assembly to measure low rates of liquid accumulation. The cylinder has a close-fitting piston, and the pressure of oil from pump (27) is used to move the piston and vary the volume of the cylinder as required to accommodate the liquid phase being accumulated. The position of the piston and hence the volume of the cylinder is accurately indicated by a protruding piston rod and micrometer attachment. In practice the meniscus of the liquid being accumulated and measured is maintained at the midpoint of the window (12) by withdrawing the liquid through the bottom of the accumulator into cylinder (26) at manually controlled rates. A stop watch is used to determine the time required to accumulate a measurable volume of the liquid. The cylinder has a capacity of 40 cc. and is useful for measuring the rate of accumulation of water and hydrocarbon liquid also when hydrocarbon liquid-gas ratios are less than 0.1 gal. per million cubic feet.

Distribution of Water in Tubing of a Flowing Well

A determination was made of the liquid-gas ratio of water in the tubing of a flowing gas-condensate well located in the Saxet field near Corpus Christi, Tex. The pump for injecting water into the stream of hydrocarbon fluid withdrawn from a well by means of a wellhead sampling nozzle was used successfully to provide a continuous sample of fluid for test purposes containing the proportion of water and liquid

hydrocarbons that the fluid flowing from the well contained. The phase relationships of this sample were determined at the pressures and temperatures that had been measured at different depths in the tubing of the flowing well by means of recording subsurface instruments. The results showed that, of the water recovered in the tank at the surface only a trace was liquid phase in the reservoir; the rest was vapor phase diluted by hydrocarbon gas. The liquid-gas ratio of water in the flowing fluid at different depths increased almost linearly as depth decreased until at the wellhead the water liquid-gas ratio was 95 per cent of the ratio at the water collecting tank.

The results of the field tests are illustrated in Fig. 5. In Section B the pressures and temperatures measured in the tubing while the well was flowing at a rate of 4.0 million cubic feet per day are shown as a function of depth. In Section A, liquid-gas ratios for hydrocarbons and water in the flowing fluid are shown separately for the depths to which they apply. The liquid-gas ratios are based on the flowing fluid rather than on the material in place. If a part of the hydrocarbon and water liquid phases move on the tubing wall as liquid films at velocities relatively slower than the vapor velocities the liquid-gas ratios based on all the material in, for example, 1-ft. length of tubing would be greater than the ratio shown in Section A of Fig. 5. It is for this reason that the ratios are referred to as minimum ratios. At least the amounts of liquid indicated will be present with gas at the respective depths whether a tubing wall film of significant thickness is present or not.

Hydrocarbon Liquid-Gas Ratios

The phase relations of the hydrocarbon sample were determined in the temperature range 86° to 280° F. and over the pressure range 450 to 3,200 psia. By selection of liquid-gas ratio data corresponding to pressures and temperatures measured at different depths in the flow string it is possible to show what the hydrocarbon liquid-gas ratios would be at these depths, and this was done to determine the curve in Section A. The dew-point pressure of the hydrocarbon fluid at reservoir temperature was less than reservoir pressure so that the hydrocarbon liquid phase did not form at the test flow rate until the fluid had moved up the tubing more than 600 ft. The liquid-gas ratio increased as the fluid approached the surface until, at well-head pressure and temperature, the ratio was at least 0.76 gal. per million cubic feet.

Most of the hydrocarbon liquid-gas ratio data were determined without the water-injection pump in operation, but some were determined at flow-string pressures and temperatures with the pump in operation. No. significant difference in values of the ratios above 0.1 gal. per million cubic feet were effected by injection of the relatively small quantities of water required, but the data obtained were not conclusive as to the effect of injected water on experimental values of the hydrocarbon - fluid dew - point pressures.

Water Liquid-Gas Ratios

Water was injected into the flowstream of the well-head hydrocarbon sample at a rate such that the water liquid-gas ratio measured with the test equipment at atmospheric pressure and temperature was the same as the ratio measured on all of the fluid at the water collecting tank. Corresponding to the ratio 0.50 bbl. per million cubic feet at the water collecting tank the water injecting pump was used at an input rate such that 48 cc. of water per hour were collected with the portable accumulator and accessory equipment. Throughout the subsequent tests the rate of water input was controlled at the required value by varying the pump stroke to maintain a constant rate of withdrawal from volumetrically graduated reservoir (29), Fig. 4.

The rate at which water was collected in the accumulator was measured by means of cylinder and piston meter (26). At high pressures and temperatures the rate of water

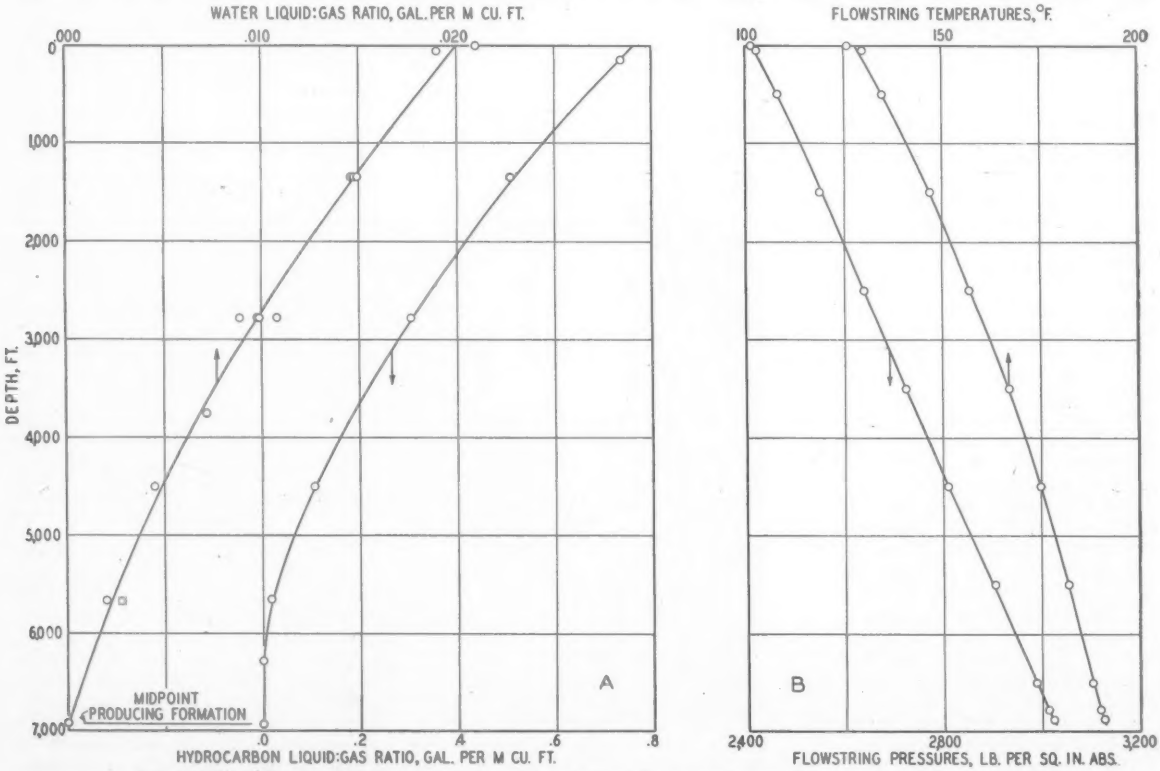


Fig. 5—Minimum liquid-gas ratios of water and condensate in the tubing of a flowing gas-condensate well

accumulation was low as most of the injected water was carried out of the accumulator as vapor with the hydrocarbon gas. The fraction of the injected water recovered as liquid in the accumulator increased as pressures and temperatures corresponding to stock tank operation were approached. In general, liquid-gas ratio measurements of water required more time and were less precise than the corresponding measurements for hydrocarbons.

The liquid-gas ratio curve for water (Section A, Fig. 5) indicates that a trace of liquid water entered the flow string from the formation. This was substantiated by analytical information on samples of water from the well under test and from an offset well producing salt water at relatively high liquid-gas ratios. The water from the offset well contained 100,000 p.p.m. of solids, whereas the well under test produced much less water containing only 200 p.p.m. of solids.

The tests with the portable equipment were made to determine in what parts of the tubing water essential to corrosion is present. The finding that liquid water is present in certain minimum liquid-gas ratios over the full length of the tubing is by no means an indication that the tubing in this well is corroding. If the well under test, however, had been a well subject to corrosion helpful information would be available for designing a treatment to remedy that difficulty. The causes of and the conditions favorable for corrosion are not fully understood, and it is possible that the characteristics of movement of the water film on the tubing wall are as significant as the concentration of corrosive components dissolved in the liquid-water phase. The amount of liquid water present in the flow string at a given depth may determine the rate of corrosion at that level. It remains to be found by additional tests whether the tubing-water distribution curve of Fig. 5 is typical of gas-condensate wells affected by corrosion.

Acknowledgment

The cooperation of C. R. Williams, vice president and general manager; H. N. Severs, production superintendent, and personnel of Chicago Corp. in the field test is gratefully acknowledged. The subsurface pressure and temperature measurements in the flowing well were obtained by E. J. Dewees, Bureau of Mines, Bartlesville. H. M. Harris, H. C. Hamontre, F. G. Archer, H. A. Carlson, Betty Hinman, N. A. C. Smith, J. A. Rhinehart, and Helen Cramer are members of the Bureau of Mines who assisted the authors with the experimental work and preparation of the manuscript. The investigations were under the supervision of R. A. Cattell, chief, petroleum and natural gas division, Bureau of Mines, and H. C. Fowler, supervising engineer, and R. E. Heithecker, former engineer in charge of production, Petroleum Experiment Station, Bartlesville.

References

1. Bacon, Thomas S., High - Pressure Production - Equipment Corrosion, A.P.I. Drilling and Production Practice, 1944, p. 157.
2. Eilerts, C. K., and others, Portable Equipment for Measuring Properties of Fluids from Gas-Condensate Wells, A.G.A. Monthly, April 1944, p. 148.

Dana Whitten, released from the Army Air Forces, and **Hans Winkler,** released from the Navy, have rejoined Sun Oil Co. as members of its geological staff in the West Texas-New Mexico district, with headquarters in Midland, Tex.

Lt. Col. Donald C. O'Hara, recently released from Army service, has joined the staff of National Petroleum Association in its new industrial relations department, with offices in Washington. Colonel O'Hara graduated from Michigan State College in 1937 and received his law degree from George Washington University in 1941. At the time of his discharge from the Army he was executive officer, office of the quartermaster general.

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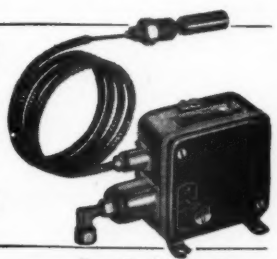
Magneto Ignition Applications. Sounds an alarm only . . . grounds dual magneto . . . grounds magneto only . . . grounds magneto and sounds an alarm or lights a signal light.

Dual Ignition Applications. Opens battery circuit and grounds magneto.



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Application of Diethylene Glycol-Water Solution for Dehydration of Natural Gas

by N. K. Senatoroff

THE use of liquid absorbents for dehydration of natural gases has been known to the gas industry for many years, and much engineering effort has been applied to perfecting the design of this type of dehydration plant. Numerous articles in technical literature have described in detail the successful application of liquid absorbents to the large volume and high operating pressure gas dehydration requirements of modern transmission line design. However, few engineering data have been published on the actual design of these plants, and there still appears to be ample room for improvement in the presently operating plants before they can be termed perfect.

The first commercial dehydration plants using solutions of diethylene glycol were built in this country in the late thirties. Their original design was influenced, to a considerable extent, by the idea of possible reconversion to the calcium chloride absorbent in the event the glycol solution proved too expensive or otherwise unsatisfactory.

The diethylene glycol (DEG) absorbent has since proved to be a very satisfactory substitute for the calcium chloride solution, due primarily to the greater dew point depression obtainable with it, and to the absence of the danger of corrosive action by the absorbent under the most commonly encountered operating temperature and/or pressures. During the last 3 or 4 years we have witnessed successful application of the DEG absorbent to the dehydration of natural gas at pressures in excess of 750 psig., and the application of the DEG solution to dehydration of natural gas at operating pressures in excess of 1,000 psig. was first tried on the Pacific Coast this year in connection with operation of the recently completed Goleta-Ventura 16-in. natural-gas transmission line.

This paper has been prepared with the idea of presenting some of the basic process engineer's computations pertaining to the design of water vapor absorption equipment, which might be of interest to those considering the use of the process, and to the men connected with the supervision and maintenance of these plants.

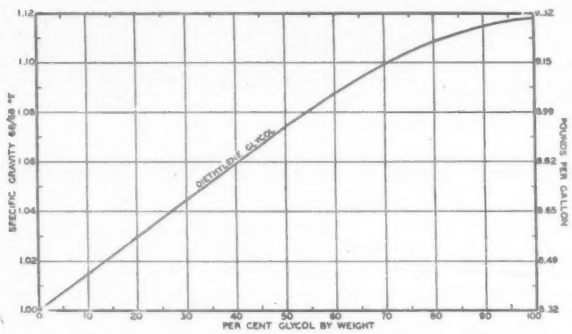


Fig. 1—Specific gravity and weight per gallon of aqueous solutions at 68° F.

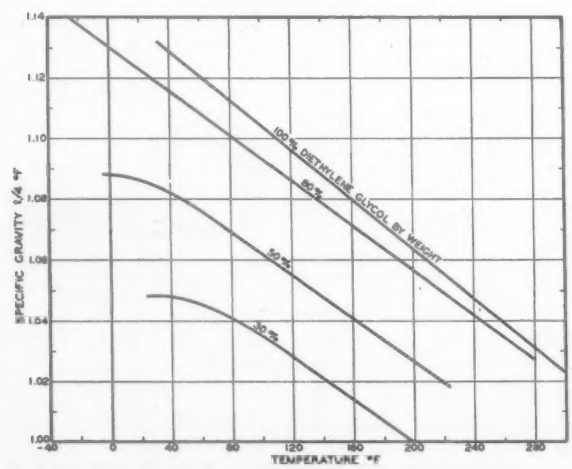


Fig. 1a—Specific gravity of aqueous diethylene glycol solutions at various temperatures

N. K. Senatoroff, following his graduation from California Institute of Technology in 1928, immediately entered the utility industry with the old Los Angeles Gas and Electric Co. Upon the merger of that company with Southern California Gas Co., he became affiliated with Southern Counties Gas Co., and has since served that company in a number of technical capacities: Chemist (1937); research engineer (1940); chemical engineer (1941). On the subject of dehydration he has been the author of the following papers which have been published in the Proceedings of the Pacific Coast Gas Association: "Corrosion Study of Bolts in Dehydrating Tower Using Calcium Chloride Brine," (1939); "Internal Corrosion of Gas Dehydrating Equipment by Calcium Chloride Brine," (1942); "Coiled-Pipe Dephlegmator for Rectifying Column in a Diethylene Glycol Natural Gas Dehydration Plant" (1944). The accompanying article was presented as a paper at the transmission conference, Pacific Coast Gas Association, in March.

Water-Vapor Absorption Equipment

Rigorous engineering design of absorption equipment in the present case was impossible because of the complete lack of data on the properties and behavior of DEG solution at 1,000 psig. pressure, and the commonly accepted method of obtaining engineering and performance data by construction of a pilot plant was unthinkable because of time limitations imposed on the completion of the plant.

In view of these difficulties, it was finally decided

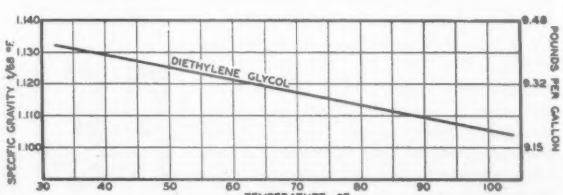
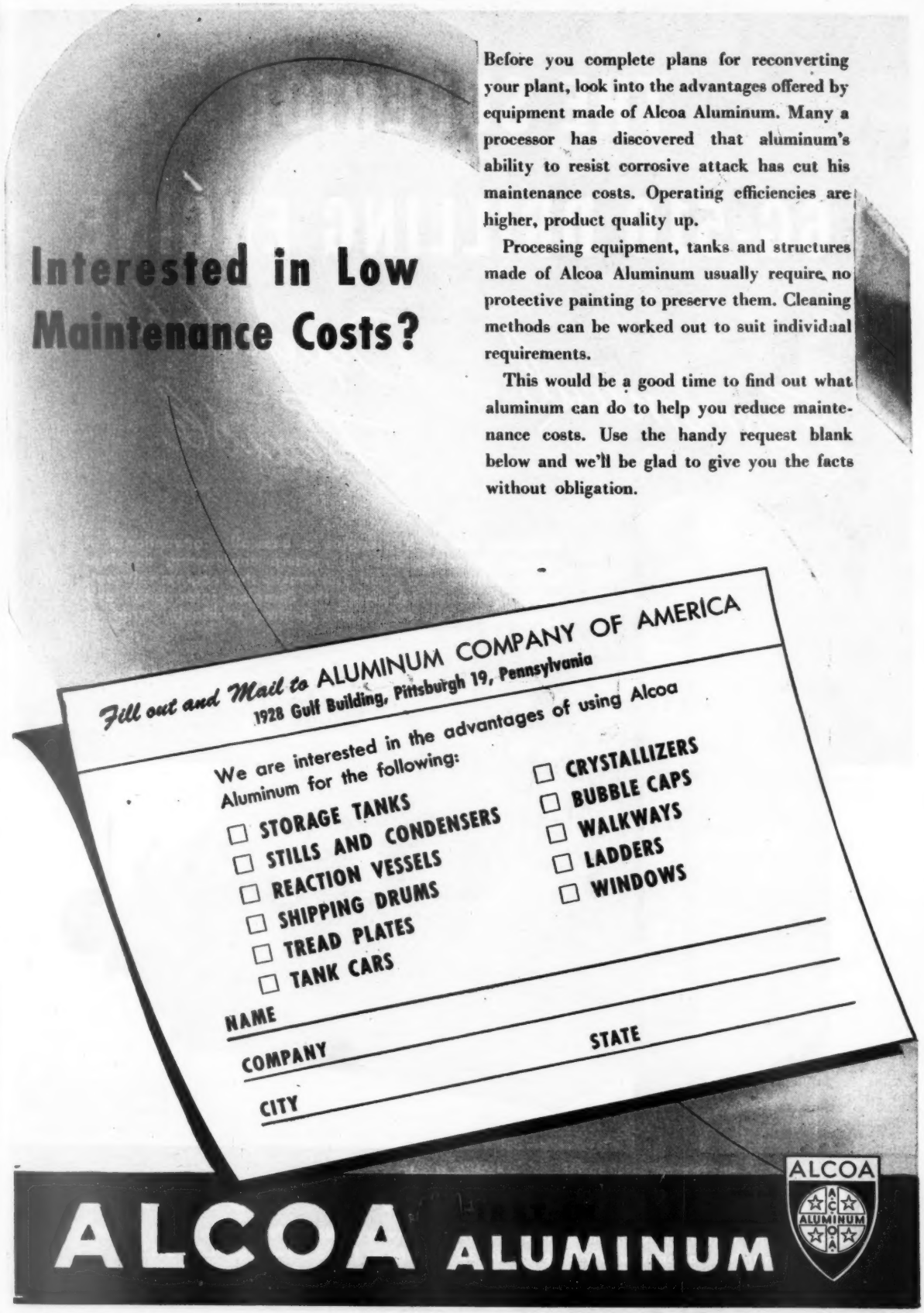


Fig. 1b—Specific gravity and weight per gallon at various temperatures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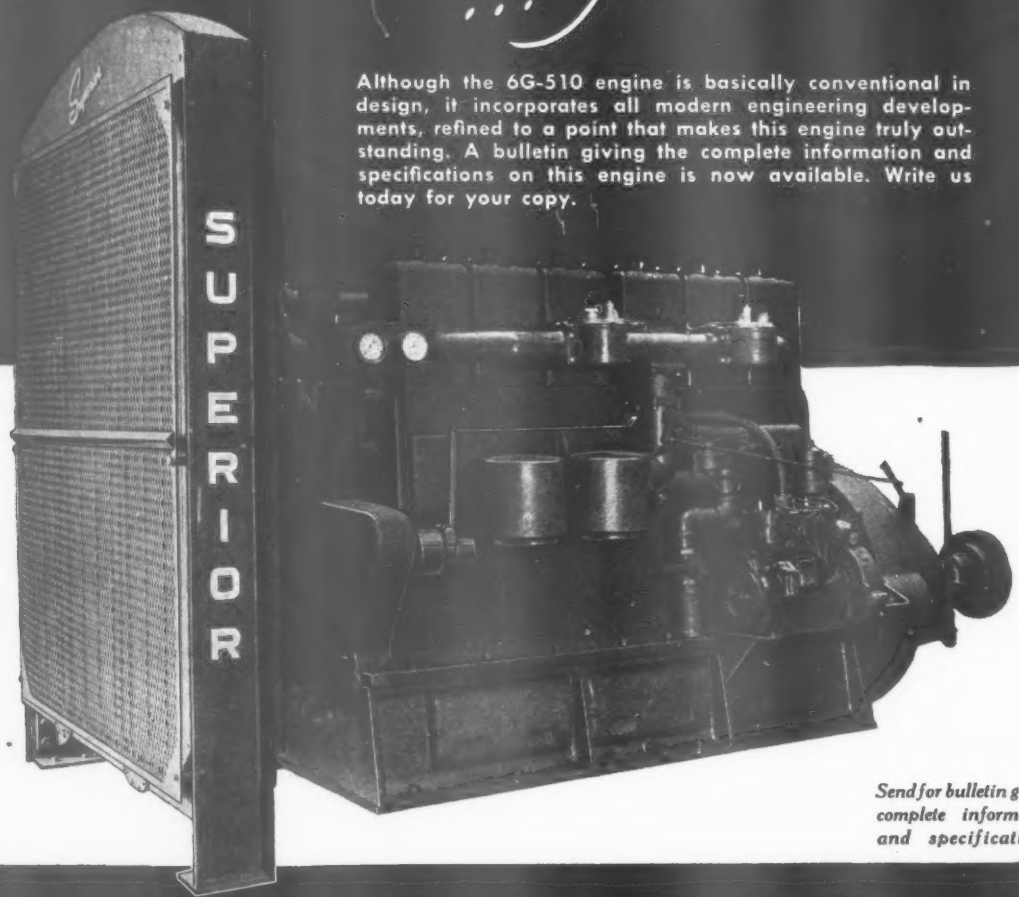

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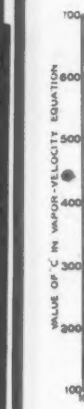
VALUE OF 'C' IN VAPOR-VELOCITY EQUATION
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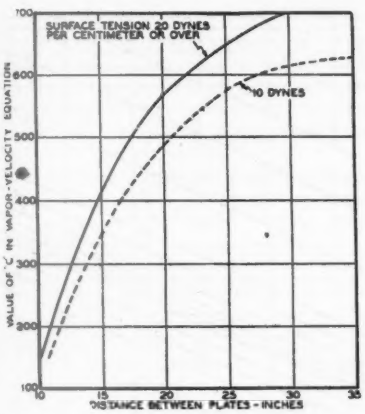

SURFACE TENSION 20 DYNES PER CENTIMETER OR OVER
10 DYNES
VALUE OF 'C' IN VAPOR-VELOCITY EQUATION
DISTANCE BETWEEN PLATES - INCHES

Fig. 2—(Left) Effect of tray spacing on allowable vapor velocity

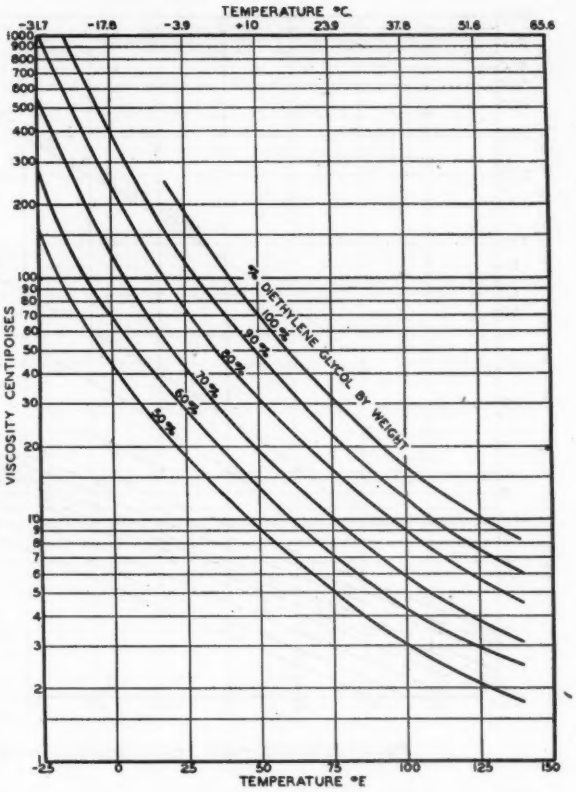


Fig. 2a—(Right) Viscosity of aqueous diethylene glycol solutions at various temperatures

to limit the design computations for the absorption equipment to purely theoretical studies of the effect of increased operating pressure on the important phases of the absorption process, taking, as a basis for the new equipment design computations, the original absorption equipment design of the old 400 psig. DEG dehydration plant. The justification for such an approach to the solution of the problem was found in the assumption that many features of the design defy exact computation any way, and engineering practice has frequently produced successful design of equipment even though the theoretical calculations were far from complete.

Selection of absorber type.—In the selection of the absorption equipment, the bubble cap or the plate type tower absorber was preferred to the packed type tower for the same reasons which governed the selection of the 400 psig. absorber.

1. The bubble cap type tower gives more efficient gas-liquid contact than the packed type.

2. The bubble cap tower seldom presents difficulties from channeling of gas and liquid streams.

The bubble cap tower's total weight is considerably less than that of the packed tower. In regions subject to earthquakes, this factor acquires considerable importance.

4. The bubble cap tower, fitted with manways through the plates, can be cleaned and inspected at less cost than the packed tower.

5. Nearly all "modern" towers are of the bubble cap type.

Outline of computations.—Following are the important design computations that were made by the engineers of Southern Counties Gas Co., in order to provide structural detail specifications, and a set of complete drawings for the manufacturers of the pressure vessel equipment to bid on the fabrication of an absorber, bubble cap type, for the dehydration of natural gas under the following operating conditions:

Pressure, psig.: Gas into absorber, 1,000; gas out of absorber, 998.

Temperature, °F.: Gas into absorber, 70; gas out of absorber, 72.

Dew point temperatures, °F.: Gas into absorber, 70; gas out of absorber, 30.

General data: Gas volume treated, 50 M.°c.f. per day.

Specific gravity of DEG-water solution: Into absorber 1.117 (95 per cent by weight DEG—5 per cent by weight water); out of absorber, 1.115 (90 per cent by weight DEG—10 per cent by weight water). (See Fig. 1.)

Temperature of DEG-water solution, °F.: Into absorber, 70; out of absorber, 72.

Circulation rate of DEG-water solution: 5-10 g.p.m., or 300-600 g.p.h., or 144-288 gal. per M.°c.f. of gas treated.

In a design project of this kind, many figures dealing with the physical properties of the materials involved in the process are used over and over again in the computations. Delay and confusion have been avoided by deriving and compiling these figures in a separate paragraph at the start of the work.

Since the laws of ideal gases and solutions are not applicable to the natural gas and DEG streams at higher pressures with an accuracy sufficient for engineering calculations, quantitative relationship among compositions, water vapor contents, velocities, densities, pressures, viscosities, weights and other often used properties of natural gas and of the liquid absorbent had to be computed for frequent reference.

THE P-V-T RELATIONSHIP OF PARAFFIN HYDROCARBONS OF THE AVERAGE MOLECULAR WEIGHT OF NATURAL GAS MIXTURES

Gas Analyses—Goleta-Ventura Fields

(Combustion method)—Typical range of composition—per cent by volume:

Carbon dioxide	CO_2	0.1	0.4
Methane	CH_4	76.0	84.5
Ethane	C_2H_6	22.9	13.0
Oxygen	O_2	None	0.5
Nitrogen	N_2	1.0	1.6

RANGE OF MOLECULAR WEIGHTS OF THE GAS

	Mol fraction	Mol wt.		Mol fraction	Mol wt.	
CO_2	0.001	× 44.01	= 0.044	0.004	× 44.01	= 0.176
CH_4	0.760	× 16.04	= 12.190	0.845	× 16.04	= 13.554
C_2H_6	0.229	× 30.07	= 6.886	0.130	× 20.07	= 3.909
O_2	0.000	× 32.00	= 0.000	0.005	× 32.00	= 0.160
N_2	0.010	× 28.02	= 0.280	0.016	× 28.02	= 0.448
	1.000		= 19.400	1.000		= 18.247

The average mol wt. of the gas mixture $= \frac{19.400 + 18.247}{2} = 18.824$

The average specific gravity (air = 1.0) $\frac{18.824}{28.966} = 0.650$

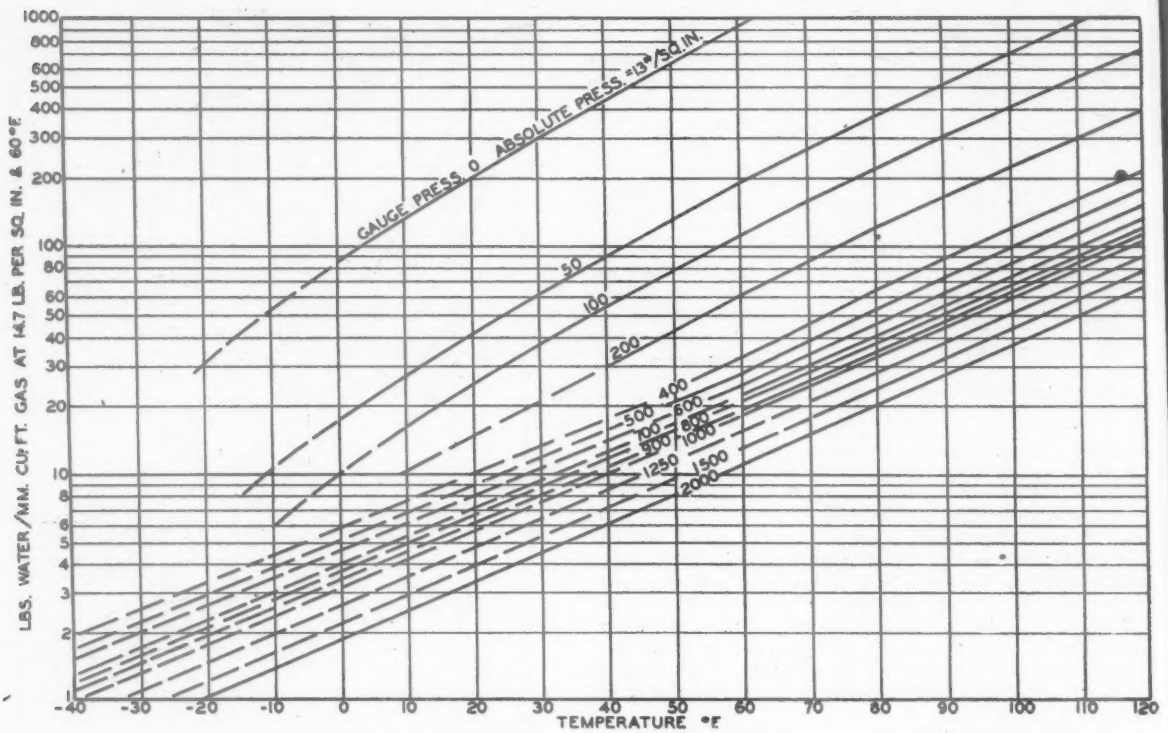


Fig. 3—Saturated water vapor content of natural gas. (University of Oklahoma Research Institute)

The application of the pseudocritical method to calculations of the deviation factor for natural gas is best illustrated by the following examples:

Problem 1.—Calculate the volume at standard conditions (14.73 psia. and 60° F.) that would be occupied by the gas contained in 1 cu. ft. of space at pressure of 1,014.73 psia. and 70° F. (average analysis of the gas is given in the following tabulation):

Component (average)	A Mol fraction	B Crit. T (°F. abs.)	C Crit. P (psia.)	D A×B	E A×C
Carbon dioxide	$\frac{0.001 + 0.004}{2} = 0.002$	549	1,072	1.098	2.144
Methane	$\frac{0.760 + 0.845}{2} = 0.803$	344	673	276.232	540.419
Ethane	$\frac{0.229 + 0.130}{2} = 0.180$	550	712	99.000	128.160
Oxygen	$\frac{0.000 + 0.005}{2} = 0.002$	278	730	0.556	1.460
Nitrogen	$\frac{0.010 + 0.016}{2} = 0.013$	227	492	2.951	6.396
	$= 1.000$			379.837	678.579

Tc = pseudocritical temperature = 379.84° F. abs.
Pc = pseudocritical pressure = 678.58 psia.

$$Tr = \text{reduced temperature} = \frac{(460° + 70°)}{379.84} = \frac{530° \text{ F. abs.}}{379.84} = 1.395$$

$$Pr = \text{reduced pressure} = \frac{1{,}014.73 \text{ psia.}}{678.58} = 1.495$$

The compressibility factor Z was obtained from published work on "Deviations of Natural Gas From Ideal Gas Laws," by George Granger Brown, consulting engineer and professor of chemical engineering, University of Michigan.

$$Z = 0.825 \qquad (Y = 1/Z = 1.2125)$$

Therefore, the given gas at standard conditions would occupy a volume of:

$$V_o = \frac{1{,}014.73 \text{ psi. abs.} \times 1 \times (460° \text{ F.} + 60° \text{ F.})}{(460° \text{ F.} + 70° \text{ F.}) \times (14.73 \text{ psia.})} \times \frac{1}{0.825} = 81.93 \text{ cu. ft.}$$

Not considering "deviation," the result would have been:

$$V_i = \frac{1{,}014.73 \text{ psi. abs.} \times 1 \times (460° \text{ F.} + 60° \text{ F.})}{(460° \text{ F.} + 70° \text{ F.}) \times (14.73 \text{ psia.})} = 67.59 \text{ cu. ft.}$$

Not considering the deviation, the error in computing volume flow through the absorber would have been 17.5 per cent low.

Problem 2.—Calculate the volume at standard conditions (14.73 psia. and 60° F.) that would be occupied by the gas contained in 1 cu. ft. of space at pressure

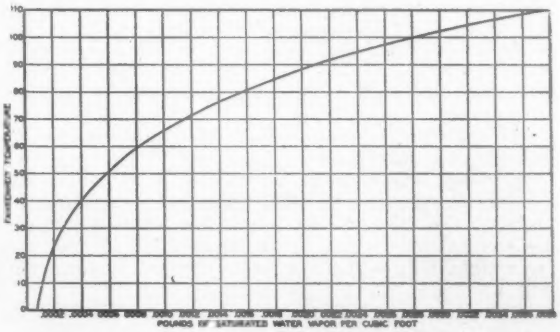


Fig. 3a—Water-vapor chart. Weight of saturated water vapor from 0° to 110° F. in pounds per cubic foot of gas mixture at 14.73 psia.

of 414.73 psia. and 70° F. (average analysis of the natural gas mixture being the same).

For the purpose of comparison of the two methods of computation, we are using R. V. Dunkle's article on "Deviation of Natural Gas from Boyle's Law," P.C.G.A. Proceedings, 1944, to arrive at the following pseudocritical temperatures and pressures:

Basis of calculations:

Specific gravity (S), carbon dioxide fraction (C), and the heating value of the gas mixture (H).

Average mol. weight of the gas = 18.824 lb. (see above).

Average specific gravity (air = 1.0) = 0.650.

Average heating value (B.t.u./cu. ft., dry) =

$$\text{Methane value } \frac{(0.760 + 0.845) \times 1{,}015}{2} = 815.05$$

$$\text{Ethane value } \frac{(0.227 + 0.130) \times 1{,}795}{2} = 321.30$$

$$1{,}136.34$$

Average carbon dioxide mol fraction = 0.0025.

Tc = pseudocritical temperature = 128.5 + 90.1 (S) + 0.1632 (H) + 244 (C) = 373.2° F. abs.

Pc = pseudocritical pressure = 670.7 — 183.9 (S) + 0.1028 (H) + 683 (C) = 669.7 psia.

$$\text{Tr} = \text{reduced temperature} = \frac{70° \text{ F.} + 460° \text{ F.}}{373.2° \text{ F.}} = 1.420$$

$$\text{Pr} = \text{reduced pressure} = \frac{669.7 \text{ psia.}}{400 \text{ psig.}} = 0.597$$

$Y_{60} = 1/Z = 1.072$

Therefore, the given gas at standard conditions would occupy a volume of:

$$V_o = \frac{414.73 \text{ psia.} \times 1 \times (460° \text{ F.} + 60° \text{ F.})}{(460° \text{ F.} + 70° \text{ F.}) \times (14.73 \text{ psia.})} \times 1.072 = 29.61 \text{ cu. ft.}$$

$$V_1 = \frac{414.73 \text{ psia.} \times 1 \times (460° \text{ F.} + 60° \text{ F.})}{(460° \text{ F.} + 70° \text{ F.}) \times (14.73 \text{ psia.})} = 27.62 \text{ cu. ft.}$$

The volumetric error in the case of the 400 psig. pressure would amount to 7.05 per cent.

Density of gas/1 cu. ft. at standard conditions = 0.0765 × 0.650 × 1.00 = 0.0497 lb.

Density of the gas/1 cu. ft. of space at 400 psig. = 0.0765 × 0.650 × 29.61 cu. ft. = 1.472 lb.

Density of the gas/1 cu. ft. of space at 1,000 psig. = 0.0765 × 0.650 × 81.93 cu. ft. = 4.072 lb.

Diameter of absorber.—The bubble cap tower is designed to give the most efficient countercurrent contact between the liquid absorbent and the gas, and to limit the amount of absorbent used, per unit of gas treated, to the lowest possible quantity adequate to dissolve the desired constituent. In so doing, an intimate contact is necessary, but too high a gas velocity results in entrainment and consequent losses of an expensive DEG solution.

Entrainment is governed by several factors, some of which are: superficial velocity of the gas stream, density of the gas, density of the liquid absorbent and the structural design of the bubble cap plates. These factors are related to one another as shown in the following equation:

$$W = C \sqrt{d_s (d_l - d_s)}$$

(See "Fractionating Columns," Ref. Nat. Gas. Mfg., January 1934)

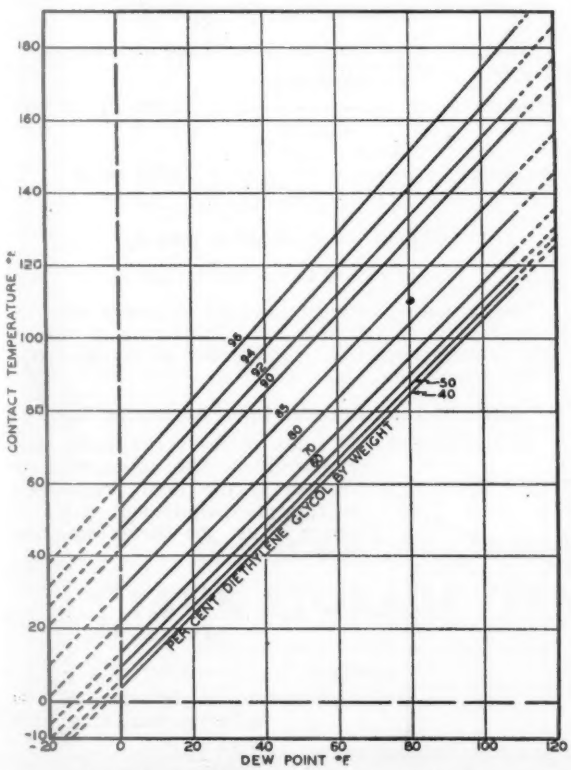


Fig. 3b—Equilibrium water dew points for diethylene glycol solutions. (From Petroleum Engineer, April 1943)

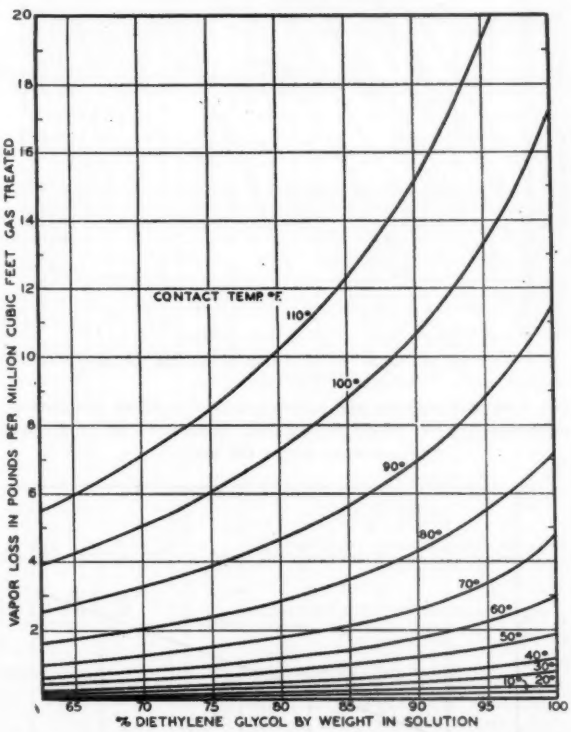


Fig. 3c—Approximate diethylene glycol vapor loss by treatment of gas at atmospheric pressure with various aqueous solutions at various temperatures. (Calculations based on vapor-pressure determinations at 77° F. (25° C.)

where

W = mass velocity, lbs. per sq. ft. per hr.

d_1 = density of liquid, lbs. per cu. ft. (at tower temp.)

d_2 = density of natural gas stream, lb. per cu. ft. (at tower cond.)

C = a constant

The value of the constant C is dependent on the tray spacing, the properties of the liquid, and the construction of the bubble cap plate.

In order to use the foregoing equation, it is necessary to determine the value of C experimentally, or from a curve—Fig. 2 (Dr. G. G. Brown and Ind. Eng. Chem.), or from the operating data of identically designed equipment. We estimated the value of C from performance of the 400-psig. bubble cap absorption tower as follows:

Capacity of the 400-psig. absorber (max.) had been established to be equal to 30 M.°c.f./day.

Cross-sectional area of 48 in. o.d. absorber in sq. ft.

$$= \frac{\pi \times (ID'')^2}{4} = 0.785 \times \left(\frac{48'' - 2''}{12''}\right)^2 = 11.534 \text{ sq. ft.}$$

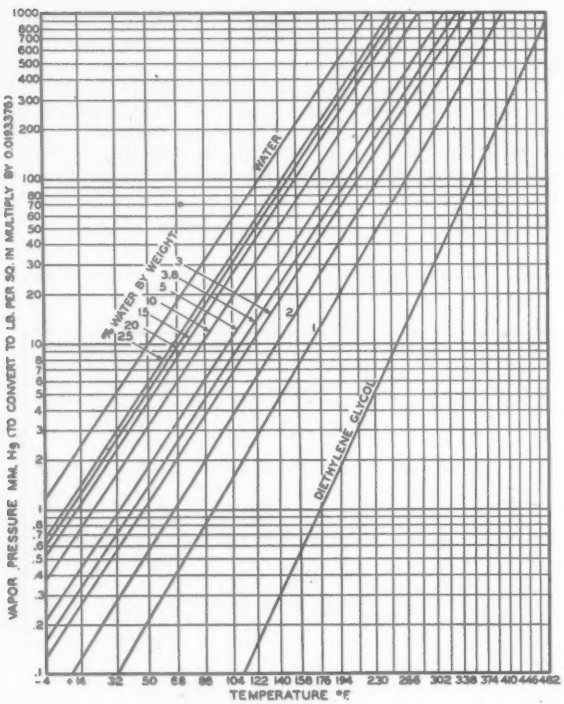

VAPOR PRESSURE MM. Hg (TO CONVERT TO LB. PER SQ. IN. MULTIPLY BY 0.0193368)
WATER
% WATER BY WEIGHT
DIETHYLENE GLYCOL
TEMPERATURE °F

Fig. 4—Vapor pressure and boiling points of aqueous solutions of diethylene glycol. (From boiling-point determinations at various pressures above 100 mm.)

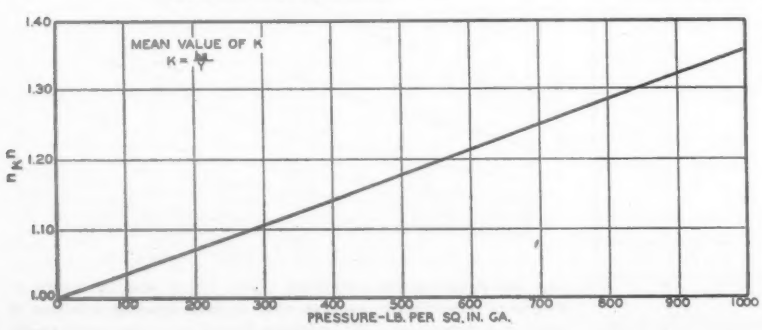


Fig. 5

Specific gravity of the gas = 0.650 (air = 1.0)

d_1 = **density of DEG (90 per cent)** = Sp. gravity solution × density of water = 1.115 × 62.2614 = 69.422 lb./cu. ft.

d_2 = **density of gas** = 1.472 lb./cu. ft.

$$\text{Mass velocity, } W = \frac{30{,}000{,}000 \text{ cu. ft.} \times 0.0765 \times 0.650}{11.534 \text{ sq. ft.} \times 24 \text{ hours}}$$

$$= 5{,}386$$

Therefore:

$$C = \frac{W}{\sqrt{d_2 (d_1 - d_2)}} = \frac{5{,}386}{\sqrt{1.472\,(69.422 - 1.472)}}$$

$$= \frac{5{,}386}{\sqrt{100.0224}} = 538.5$$

After having determined the value of C, the diameter of the 1,000 psig. absorber is calculated as follows:

$$W_{1000} = \sqrt{d_2 (d_1 - d_2)}$$

where

d_1 = density of DEG (90 per cent), same as above = 69.422 lb./cu. ft.

d_2 = density of gas = 4.072 lb./cu. ft.

$W_{1000} = 538.5 \sqrt{4.072\,(69.422 - 4.072)}$

$= 538.5 \sqrt{4.072 \times 65.350}$

$= 538.5 \sqrt{266.105}$

$= 538.5 \times 16.313 = 8{,}784.55$

The designed capacity of the absorber to handle 50 M.°c.f./day, in terms of the weight load in pounds, is equal to:

$$\frac{50{,}000{,}000 \text{ cu. ft.} \times 0.765 \times 0.650}{24 \text{ hours}}$$

$$= 50{,}000 \times 2.071 = 103{,}550 \text{ lb.}$$

Thus, the cross-sectional area of the absorber is determined to be $\frac{103{,}550 \text{ lb.}}{8{,}784.55} = 11.788$ sq. ft. and

$$(\text{diameter})^2 = \frac{\text{Area}}{\pi/4} = \frac{11.788}{0.785} = 15.016 \text{ sq. ft.}$$

$$\text{Diameter} = \sqrt{15.016} = 3.875 \text{ ft.}$$

$$3.875 \times 12 \text{ in.} = 46.5 \text{ in. i.d.}$$

The actually designed absorber diameter was increased to 50 in. i.d. in order to take care of unforeseen contingencies that might occur in the operation of the dehydration plant.

Effect of Total Pressure Upon Absorption Rate

In the quantitative study of the variation in rates of absorption, due to increase or decrease of the total pressure in the absorption equipment, it is customary to use the Stefan equation (Sherwood):

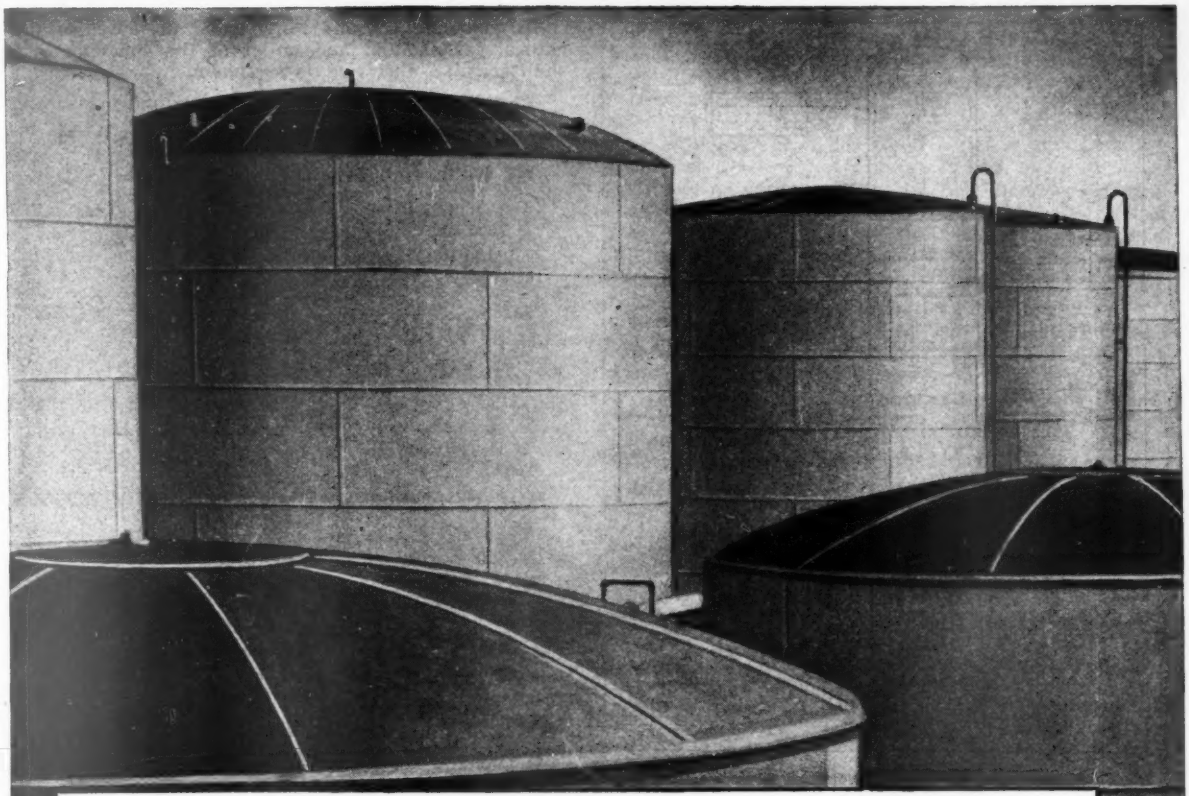
$$N_a = \frac{DP}{RTx} \ln \frac{Pb_2}{Pb_1}$$

where

N_a = rate of diffusion for gas "a," mols./ (unit area) (unit time)

D = diffusion coefficient or diffusivity, cm.²/sec.

P = total pressure, atm.



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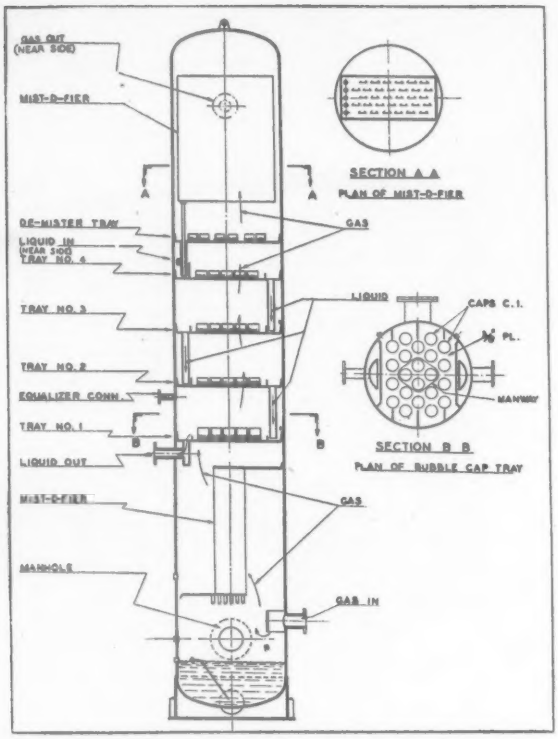

Fig. 6—Structural details of diethylene glycol type water vapor absorber

R = gas law constant
T = absolute temperature, °R or °K
x = effective total film thickness
Pb_2 = partial pressure at the inert or nondiffusing gas at outlet, atm.
Pb_1 = partial pressure of the inert or nondiffusing gas at inlet, atm.

The problem of checking the theoretical effect of total pressure on the rate of water vapor absorption by the glycol solution could be stated as follows: By what percentage would the rate of absorption vary while increasing the total operating pressure on the plate tower from 400 psig. to 1,000 psig.? Using the Stefan equation:

$$\frac{N_{a_{1000}}}{N_{a_{400}}} = \frac{[DP/RTx\ (1n\ Pb_2/Pb_1)]_{1000}}{[DP/RTx\ (1n\ Pb_2/Pb_1)]_{400}} = \frac{(1n\ Pb_2/Pb_1)_{1000}}{(1n\ Pb_2/Pb_1)_{400}}$$

Because it has been shown[9] that DP/RTx is independent of pressure in absorption processes in which the liquid film resistance becomes negligible and only the gas film resistance plays a controlling part in the rate of diffusion. This simplification of the general equation is permissible because of the high solubility of the water vapor (solute) in the glycol absorbent (solvent) of any concentration.

Using experimental data of University of Oklahoma Research Institute, "Saturated Water Vapor Content of Natural Gas," the following partial pressures of water vapor and natural gas were computed:

Water-vapor content—lb./M.³c.f. at 70° F. dew point and 400 psig. = 46.0.

Water-vapor content—lb./M.³c.f. at 30° F. dew point and 400 psig. = 13.4.

Water-vapor content—lb./M.³c.f. at 70° F. dew point and 1,000 psig. = 24.5.

Water-vapor content—lb./M.³c.f. at 30° F. dew point and 1,000 psig. = 7.6.

To calculate Pb_1 and Pb_2 (partial pressures of the natural gas at inlet and outlet of the contactor) we shall calculate their values as shown:

Partial pressures = mol fraction × total pressure.

Mol fraction gas = 100 minus mol fraction H_2O.

For 400-lb. and 70° F. D.P.:

$$\frac{46.0\text{ lb.}}{18.016\text{ lb.}} = 2.5533 \text{ mols of } H_2O \text{ per M.}^3\text{c.f.}$$

$$1\text{ M.}^3\text{c.f.} = \frac{1{,}000{,}000 \times 0.0765 \times 0.650}{18.824} = 2{,}641.575$$

mols of natural gas

$$\frac{2.5533}{2{,}641.575} \times 100 = 0.0967 \text{ per cent } H_2O$$

$$Pb_1 = (1 - 0.000967) \times \frac{414.73}{14.73} = 0.999033 \times 28.1554$$

= 28.1282 partial pressure of inlet gas in atmospheres.

For 400-lb. and 30° F. D.P.:

$$\frac{13.4\text{ lb.}}{18.016\text{ lb.}} = 0.7438 \text{ mols } H_2O \text{ per M.}^3\text{c.f.}$$

$$\frac{0.7438}{2{,}641.575} \times 100 = 0.0282 \text{ per cent } H_2O$$

$$Pb_2 = (1 - 0.000282) \times \frac{414.73}{14.73} = 0.999718 \times 28.1554$$

= 28.1475 partial pressure of outlet gas in atmospheres

For 1,000-lb. and 70° F. D.P.:

$$\frac{24.5}{18.016\text{ lb.}} = 1.3599 \text{ mols of } H_2O \text{ per M.}^3\text{c.f.}$$

$$\frac{1.3599}{2{,}641.575} \times 100 = 0.515 \text{ per cent } H_2O$$

$$Pb_1 = (1 - 0.000515) \times \frac{1{,}014.73}{14.73} = 0.999485 \times 68.8886$$

= 68.8531 partial pressure of inlet gas in atmospheres

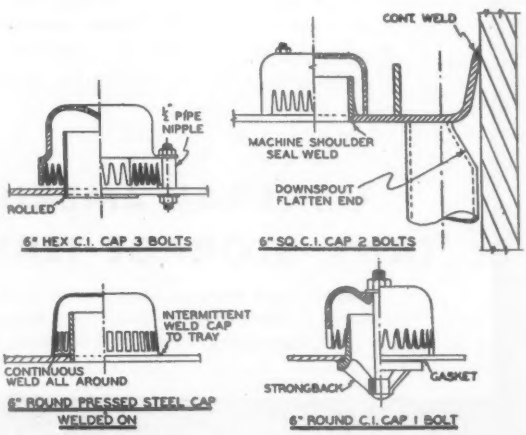

Fig. 7—Typical bubble caps

For 1,000-lb. and 30° F. D.P.:

$$\frac{7.6 \text{ lb.}}{18.016 \text{ lb.}} = 0.4218 \text{ mols of } H_2O \text{ per M.}^3\text{c.f.}$$

$$\frac{0.4218}{2{,}641.575} \times 100 = 0.0160 \text{ per cent } H_2O$$

$$Pb_s = (1 - 0.000160) \times \frac{1{,}014.73}{14.73} = 0.999840 \times 68.8886$$

= 68.8776 partial pressure of outlet gas in atmospheres

Then

$$\frac{N_s\,(1000)}{N_s\,(400)} = \frac{\ln \frac{68.8776}{68.8531}}{\ln \frac{28.1475}{28.1282}} = \frac{\ln 1.0003558}{\ln 1.0006861} = \frac{15.4517 \times 10^{-4}}{29.7867 \times 10^{-4}}$$

= 0.519 = 51.9 per cent

The diffusion rate through the controlling gas films at 1,000 lb. is 51.9 per cent of the rate of 400 lb.

However, taking into consideration the actual quantities of water to be removed from the gas, at 400 psig. and 1,000 psig. pressures, one finds that the decrease in diffusion rate is very closely compensated by the lowered weight of the water extracted. The two ratios are found to be as follows:

When operating at 400 psig. (46.0 — 13.4) = 32.6 lb. of water are removed per 1 M.^{3}c.f. of dehydrated gas.

When operating at 1,000 psig. (24.5 — 7.6) = 16.9 lb. of water are removed per 1 M.^{3}c.f. of dehydrated gas.

And the ratio of the two weights is equal to $\frac{16.9 \text{ lb.}}{32.6 \text{ lb.}}$

= 0.518 or 51.8 per cent.

Thus, the decreased rate of diffusion of 51.9 per cent is compensated by the 51.8 per cent drop in the water vapor load, and the performances of absorption equipment at 400 psig. and 1,000 psig. should be very nearly identical.

Theoretically, therefore, the increased operating pressure on the absorption equipment should not call for any change in the structural design of the absorption equipment details.

Plate spacing.—One serious cause of inefficiency in the bubble cap plate absorber is the entrainment and carryover of the contacting liquid from the lower plate to the one above. It occurs either as a result of excessive gas velocity through the bubble cap slots, which creates splashing or spouting of the liquid, or due to inadequate plate spacing, which does not allow time for small particles of liquid, suspended in the gas stream, to fall back and settle on the parent plate.

Chillas and Weir[11] report that entrainment is negligible at a velocity of 2 ft. per second, but that it amounts to 20.5 per cent at 5.5 ft. per second. In typical industrial absorbers, having trays spaced at 22 in., the entrainment is approximately as shown in the table below:

Material	Pressure	Linear velocity (ft. per sec.)	Per cent entrainment
Gasoline	Atmospheric	1.4	0.25
Gasoline	Atmospheric	3.0	0.80
Gas oil	20 mm.	10.0	1.80
Air-water	Atmospheric	0.3	0.04
Air-water	Atmospheric	2.2	0.70

Souders and Brown[10] have derived the theoretical suspending velocity and have shown the effect of tray spacing on entrainment. Normally the distance between the plates should never be less than 6 in. above the liquid level for ordinary vapor velocities.

Kallam[4] finds that the capacity of an absorber was more than doubled by increasing the tray spacing from 7 to 14 in., and that, at the same time, half as many trays gave almost as good an absorption.

The trays in petroleum oil absorbers are usually spaced at 18 to 24 in., and in some service the distance is as high as 36 in.

In our case, we have retained the 36-in. spacing of the 400 psig. absorber in the 1,000 psig. vessel, because it provides ample room for the installation of manways through the trays, renders internal inspection of the vessel less difficult, and assures minimum entrainment loss and high plate efficiency.

Determination of the number of plates in absorber.—The theoretical calculation of the number of plates needed to achieve a given absorption of one of the components from a complex hydrocarbon mixture usually requires considerable amount of either numerical or graphical computations, because of the fact that each component must be treated separately.

The computation technique for natural gas dehydration, however, is greatly simplified because the process of water vapor absorption involves the removal of only one component from the gaseous phase, namely, water vapor.

Using the method of computation covered by Laulhere and Briscoe,[8] the following number of theoretical plates were found to be needed for the 1,000 psig. absorber.

Using the equation:

$$A = \frac{0.00175G}{K}\left(S_w + \frac{18\,S_s}{M_1}\right)$$

where

A = absorption factor

G = gallons of DEG solution per 1 M.c.f. of gas =

$$\frac{10 \text{ gal./min.} \times 60 \times 24}{50{,}000} = 0.288 \text{ gal.}$$

d = specific gravity of the DEG solution (1.117 and 1.115)

S_w = per cent water by weight of DEG solution (5 and 10 per cent)

S_s = per cent DEG by weight of DEG solution (95 and 90 per cent)

M_1 = molecular weight of DEG (106.08)

$$K = y/x = k\,P_s/C\,P$$

wherein

k = ab/Y, b = the ratio of the water vapor content of gas under operating pressure to that at atmospheric pressure for the same temperature

a = the ratio of water vapor pressure at absorber conditions to that at atmospheric pressure and the same temperature

Y = superexpansibility factor (1.2125)

k = 1.358[9]

P_s = vapor pressure of water at atmospheric pressure and operating temperature (70° F.) = 0.364 psi. (See Fig. 4)

C = hygroscopic absorbent factor for DEG = 1.2[8]

P = total operating pressure in psi. = 1,014.73 psia.

Evaluating K:

$$K = \frac{1.358 \times 0.364 \text{ psi.}}{1.2 \times 1{,}014.73 \text{ psi.}} = \frac{0.494312}{1{,}217.676} = 0.0004059$$

$$A = \frac{0.00175 \times 0.288 \times 1.116 \text{ (average value)}}{0.0004059} - \left[\left(\frac{5+10}{2}\right) + \left(\frac{18 \times \frac{90+95}{2}}{106.08}\right)\right]$$

$$= \frac{0.00056246}{0.0004059} \times 23.195 = 1.3857 \times 23.195 = 32.1413$$

From the curves of "Absorption Efficiency vs. Absorption Factor and Number of Theoretical Plates,"[8] we find that one theoretical plate will give 97 per cent absorption efficiency, thus requiring at least two theoretically perfect plates per absorber. In general, the plate performance efficiency of an actual plate differs considerably from that of an ideal plate. The actual plate efficiency reportedly ranges from 70 to 90 per cent for petroleum oil columns. Designers of natural gasoline absorbers use a 55 to 65 per cent efficiency figure for low pressure columns and only 45 to 55 per cent for absorbers operating at 400 to 600 psig. pressures.

From these calculations and our own experience with the operation of the 400 psig. absorber, the new 1,000 psig. plate tower was designed with four bubble cap plates.

Miscellaneous detail design specifications.—The overflow pipe capacity is a very important factor in the efficient performance of the bubble cap plate. The capacity of these pipes is limited by the amount of liquid which can enter them, since this flows in under low head. Moreover, the unknown "frothing" coefficient of the DEG-water-natural-gasoline solution may affect their capacity to a considerable extent. For these reasons, consideration was given to the careful computation of the required size of overflow pipes.

The designed maximum rate of DEG circulation is equal to 10 gal. per minute. With an assumed frothing coefficient of 2:1, the size of the overflow pipe was computed on the basis of 20 gal. per minute volume of "frothed" solution circulation.

The "usually" recommended liquid velocity in these pipes does not exceed 4 linear inches per second. However, since in many vessel designs a velocity of 2 in. per second will not incur a large expense, the use of the low velocity figure was adopted in our absorber. The required number of 3 and 4-in. i.d. pipe size spouts for the absorber is determined as follows:

$$N_3'' = \frac{20 \text{ gal./min.} \times 231 \text{ cu. in.}}{60 \text{ sec./min.} \times 2 \text{ in./sec.} \times 7.393 \text{ sq. in.}} = 5.2$$

$$N_4'' = \frac{20 \text{ gal./min.} \times 231 \text{ cu. in.}}{60 \text{ sec./min.} \times 2 \text{ in./sec.} \times 12.73 \text{ sq. in.}} = 3.0$$

The final selection of the shape and the size of overflow pipes was based on the recommendations of engineers representing the pressure vessel manufacturing firm. In adapting their type of bubble caps, risers, and the general plate layout, it was felt that the overflow pipes should be looked upon as an integral part of the bubble cap plate assembly, and consequently the recommended shape would fit better into their standard type of plate absorber. In the final selection of design, the fabricator of the absorber was requested to provide only the necessary cross-sectional area in the overflow pipe, with no limitation as to the shape of the opening.

Bubble caps.—The exact design of the bubble cap appears to be of little importance except from the standpoint of convenience in assembling or replacing and also from the cost standpoint. Kallam[3] reports that the shape of the slots appears to have no effect on absorption efficiency. The same shape of bubble is produced with any shape of the slot. At low velocity flat disk-shaped bubbles are produced; at high gas vapor velocity a channeling occurs and a continuous elongated bubble extends through the liquid. Contrary to common belief, it appears that more effective contacting occurs at low, rather than at high velocities.

The typical dimensional relation between the outside diameter of the round caps (in inches), the riser area (in square feet), and the slot area per cap (in square feet) is given in the following table:

Cap. o.d. (in.)	Riser area/cap (sq. ft.)	Slot area/cap (sq. ft.)
3-6	0.0204-0.0232	0.0165-0.0469

The overflow dam.—The overflow weir or dam is usually designed so that it maintains 0.5 to 1.5 in. of liquid depth above the top of the bubble cap slots. In general, the plate efficiency is higher with a deep liquid seal. The depth of the seal, however, should be determined by the flow condition. The importance of this fact has been overlooked occasionally in the past and has resulted in the serious loss of DEG solution into the sump, because of inadequate free board distance between the surface of the flowing DEG and the top of the bubble cap riser.

The effective head H above the weir is determined by the formula:

$$Q = 3.33 (L - 0.2 H) \times H^{3/2} \text{ C.F.S.}^{13}$$

$$Q = 10 \text{ gal./min.} = \frac{10 \text{ gal.}}{\text{Min.} \times 7.48 \text{ gal./cu. ft.}} = \frac{1.34 \text{ cu. ft.}}{\text{Min.}}$$

$$= 0.02233 \text{ cu. ft./sec.}$$

L = Perimeter of the weir = 2.5 ft.

Assuming an arbitrary value for H of ¼ in. (0.0208 ft.) and solving the equation by the trial and error method, it was found that the effective head H of the liquid above the weir is 0.226 in. Thus, the bubble cap riser should be higher than the height of the downstream weir of the plate by at least ¼ in., in order to provide the minimum free board distance.

Mist-D-Fiers.—The importance of the complete removal of entrained liquid from the gas stream entering the bubble cap absorbers can never be overstressed if one wishes to build as foolproof a dehydration plant as possible.

To protect the plant against handling excessive amounts of entrained water, well condensate and slugs of absorption oil, some type of scrubbing device should be installed at the base of the absorber.

Highly efficient scrubbing means must also be provided at the outlet of the absorber to thoroughly remove even traces of the DEG solution, because this solution not only is expensive but is just as undesirable in the transmission line as any other type of condensate.

Our experience with the full load operation of Mist-D-Fier elements designed for a rate of 30 M.³c.f. per day at 400 psig. shows entrainment losses of less than 0.05 gal. per 1 M.³c.f. On a basis of this experience, Mist-D-Fier nests were selected and installed in the 1,000-psig. absorber.

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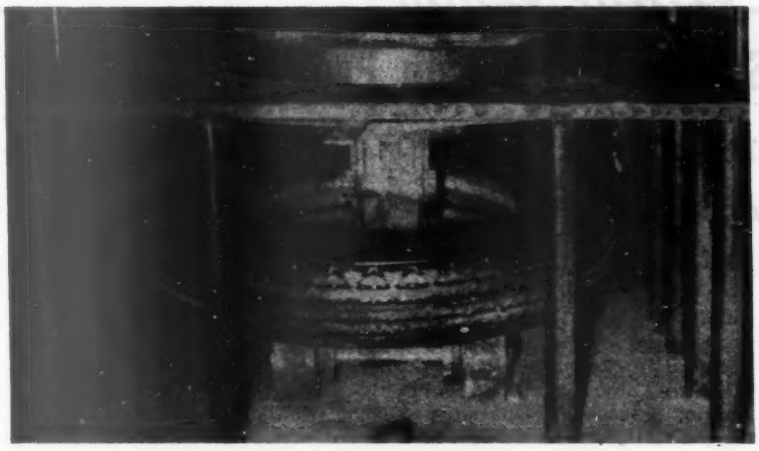
PLANT PRACTICES

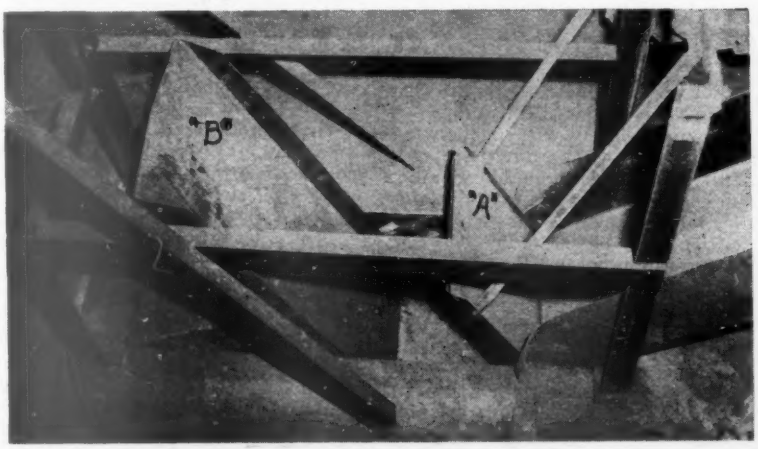


Tire Changer Saves Time in Refinery Garage

CONSTRUCTED of a section of salvaged plate and several short pieces of 2-in. pipe, the all-welded device shown in the photograph saves considerable time around the refinery garage by quickly removing the rims from truck tires. The operation is carried out by placing the tire and rim on a regular garage-type jack, placing the jack under the hole in the plate so that it is centered and running the tire up against the plate. After the tire has contacted the plate a few more lifts on the jack handle will force the rim out of the tire and through the hole in the changing table. The entire operation takes only a few minutes.

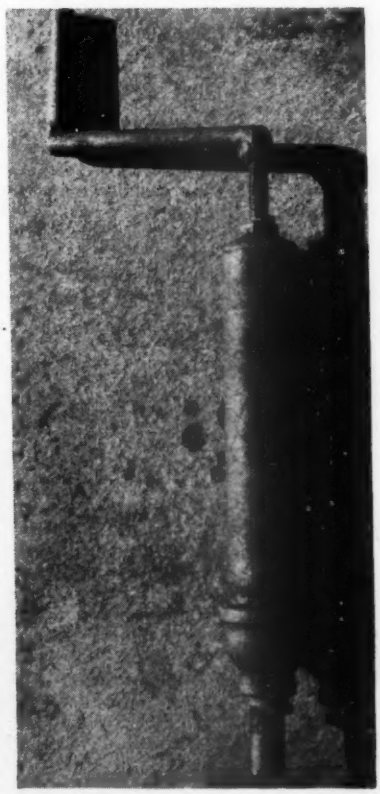
Can and Carton Chutes That Do Not Jam

EMPTY cans are transferred from the second floor of the barrel house to the filling machines on the first floor by means of two spiral chutes. Empty 5-gal. utility cans are received in cartons, which must be removed before filling the cans. The empty cartons usually jammed the chutes. To overcome this trouble a section of the bottom of the chute above the second floor ("A" in illustration) was cut out and hinged. From this opening a second straight chute was built to deliver the cartons to the point where the filled cans are packed. Another section was built to extend the carton chute above the floor line ("B" in illustration). This was hinged on the guard rail around the opening in the floor, and is lowered when cartons are sent down or raised for can delivery.



Stick Grease Maker

DRIVING journal compound is extruded into small cylinders for use in lubricated cocks installed on certain lines in the refinery. This is a hard and tough material that is made in slabs weighing 60 lb. each. When first used it was cut into small sticks by hand. A device was designed and made in the pipe shop by means of which the sticks of lubricant can be formed quickly and efficiently. An end was welded in a piece of 2-in. pipe about 12 in. long. This end was then drilled and tapped at its center for a ¾-in. screw. A screw about 12 in. long was cut to fit this tapped hole and an L-shaped handle was fastened on one end of it. A plate with a diameter to just fit into the pipe was attached to the other end of the screw. The open end of the pipe was threaded, and to this end various size reducers with 2-in. long nipples can be attached. In operation the device is held in a pipe vise. The grease is cut into pieces to feed into the 2-in. pipe. The reducer and the proper size nipple are attached to the open end of the pipe, and when the screw is turned the lubricant is forced out of the nipple. The sticks are cut to proper length and then rolled in graphite to prevent sticking when packed in boxes.



(The ideas described here are used in the Marcus Hook and Houston refineries of Sinclair Refining Co.)

PRACTICAL PETROLEUM ENGINEERING

Fluid Flow

Graphic Solutions of Design Problems

9— Flow of Gases in Horizontal Pipes

by Paul Buthod and B. W. Whiteley

THE basic equation for isothermal flow of gases in a horizontal pipe may be written as:

$$Q = 198.8 \sqrt{\frac{D^5 (P_1^2 - P_2^2)}{sfT\,Z\,L}} \qquad (9\text{-}1)$$

where the symbols are explained in the accompanying notation. This equation neglects the velocity head which from a practical standpoint is usually insignificant. The compressibility factor "Z" will, in general, vary along the length of the line since it is a function of pressure. However, accurate results may be obtained by using an average value of "Z." In a rigorous sense it would be somewhat more correct to treat "Z" as a variable in which case the basic flow equation becomes:

$$Q = 281.7 \sqrt{\frac{D^5}{sfTL} \int_{P_2}^{P_1} \frac{P\,dP}{Z}} \qquad (9\text{-}2)$$

Numerical values of the integral in the above expression may be obtained from convenient charts prepared by Clinedinst.[1] However, for practical purposes, Equation 9-1 gives as accurate results as Equation 9-2.

If the effect of velocity head is considered, the value "L_t" may be substituted for "L" in Equations 9-1 and 9-2, where:

$$L_t = L + \frac{D}{6f} \log_e \frac{P_1 Z_2}{P_2 Z_1} \qquad (9\text{-}3)$$

Substitution of this expression corrects for the velocity head; however, except in cases such that extremely large pressure drops are involved in relatively short lengths of pipe, this correction in negligible.

Equation 9-1 is based on the Darcy law using a universal friction factor correlation (Article 2). It is of some interest to compare the resultant expression with the Weymouth formula which, in the past, has been widely used in the petroleum industry. Weymouth's formula may be written as:

$$Q = 1{,}112\, D^{8/3} \sqrt{\frac{P_1^2 - P_2^2}{sLT}} \qquad (9\text{-}4)$$

Many of the charts previously published in this series are brought into use, in solving a problem on isothermal flow of gas in a pipe line, in Article 8 (December 8 issue). Discussion covered the transmission of gases at high pressures and correction factors for some of the semiempirical formulas in common use for calculating pressure losses in gas-transmission lines.

where the notation is the same as that used previously. By comparing this with Equation 9-1, it is evident that in terms of a friction factor, the Weymouth formula assumes that:

$$f = 0.0319\, D^{-0.333} \qquad (9\text{-}5)$$

Substitution of this expression for "f" in Equation 9-1 and assuming that the ideal gas laws apply, results in the Weymouth formula as expressed in Equation 9-4. From the friction factor chart (Article 2), it will be noted that in the so-called rough pipe region, the friction factor is essentially a function only of the pipe diameter. As a matter of fact, the friction factor within this region as shown by the chart (Fig. 2-2) can be expressed empirically as:

$$f = 0.0225\, D^{-0.25} \qquad (9\text{-}6)$$

For pipe diameters greater than 12 in., the Weymouth friction factor agrees closely with friction factors obtained from the chart (Fig. 2-2). However, in the lower range of pipe diameters and at the higher Reynolds numbers, the Weymouth friction may be 30 to 50 per cent greater. Johnson and Berwald[2] have found that Weymouth's formula led to considerable error when applied to lines smaller than 6 in. in diameter. Perhaps the most important difference, however, between Weymouth's formula and Equations 9-1 and 9-2 is the inclusion of the compressibility factor term to correct for deviation from the ideal gas laws.

As a concrete illustration of the factors involved in the flow of gases, an example is given using actual test data.

Example.—A natural gas (sp. gr. = 0.60) flows through 56 miles of 20-in. standard pipe (i.d. = 19.375-in.) at the rate of 89,288 M.c.f./day. The gas enters the line at 380 psia. and 60° F. Calculate the outlet pressure. (These data are taken from tests made on the Cities Service Pampa-Wichita line, reported by Miller.[3] The actual outlet pressure as determined by tests for the above flow conditions was 266 psia.)

Solution.—The pressure drop will be evaluated by means of Equation 9-1. The compressibility factor "Z" must be evaluated at an average pressure. This pressure must be assumed and checked by later trial. Assuming a 100 psi. pressure drop in the line, the average pressure would be 330 psia. Consequently, for a 0.6 sp. gr. gas, the pseudo-reduced conditions would be:

$$P_r = 0.491$$

$$T_r = 1.45$$

The compressibility factor from Fig. 6-1 is:

$$Z = 0.95$$

The viscosity function $\mu_p \div s$ = 0.0173 (Fig. 7-2).

The Reynolds number for the above flow conditions is found to be:

$$Re = 5{,}400{,}000 \quad \text{(Fig. 7-1)}$$

The friction factor for a 19.375-in. pipe and the foregoing Reynolds number is:

$$f = 0.012$$

Using a length of 56 × 5,280 = 295,000 ft., a temperature of 60° F., a friction factor of 0.012, and a specific gravity of 0.6, the value of $C = 198.8 \div \sqrt{sfTL}$ is found to be 0.190 (Fig. 8-1).

Using "C" = 0.190, rate of flow 89,288 M.c.f./day, and a compressibility factor of 0.95, the value of $\sqrt{P_1^2 - P_2^2}$ is determined as 280 (Fig. 8-2).

Fig. 9-1 may be used to find the value of P_2 which for this example is:

$$P_2 = 258 \text{ psia.}$$

The calculated reduction in pressure is 120 psi. which does not change the initial assumed value for an average "Z." Consequently, the calculated outlet pressure is:

$$P_2 = 258 \text{ psia.}$$

This computed value agrees with the actual experimental data (P_2 = 266 psia.) with an error of approximately 3 per cent.

Effect of Velocity Head

In the derivation of Equation 9-1, the kinetic energy term or velocity head, due to a difference in fluid velocity between the inlet and outlet sections, was neglected. The magnitude of this error may be calculated for the above example by means of Equation 9-3. In this case:

$$L_t = 295{,}000 + \frac{19.375}{6 \times 0.012} \log_e \frac{380 \times 0.963}{258 \times 0.941}$$

$$= 295{,}000 + 110 = 295{,}110 \text{ ft.}$$

In other words, if the velocity head were considered, the additional drop in pressure would be the same as if the line were 110 ft. longer. This correction in terms of pressure drop amounts to about 1 part in 3,000 or 0.03 per cent and, of course, is negligible for this example.

Effect of Average "Z" Factor

Equation 9-1 essentially treats "Z" as a linear function of pressure, which is approximately true over short pressure ranges. The effect of this simplification may be calculated by comparing the results with Equation 9-2. This equation may be rewritten (Article 8) as:

$$\int_0^{P_{s_1}} \frac{P_s \, dP_s}{Z} - \int_0^{P_{s_2}} \frac{P_s \, dP_s}{Z} = \frac{Q^2}{2C^2 P_c^2 D^5}$$

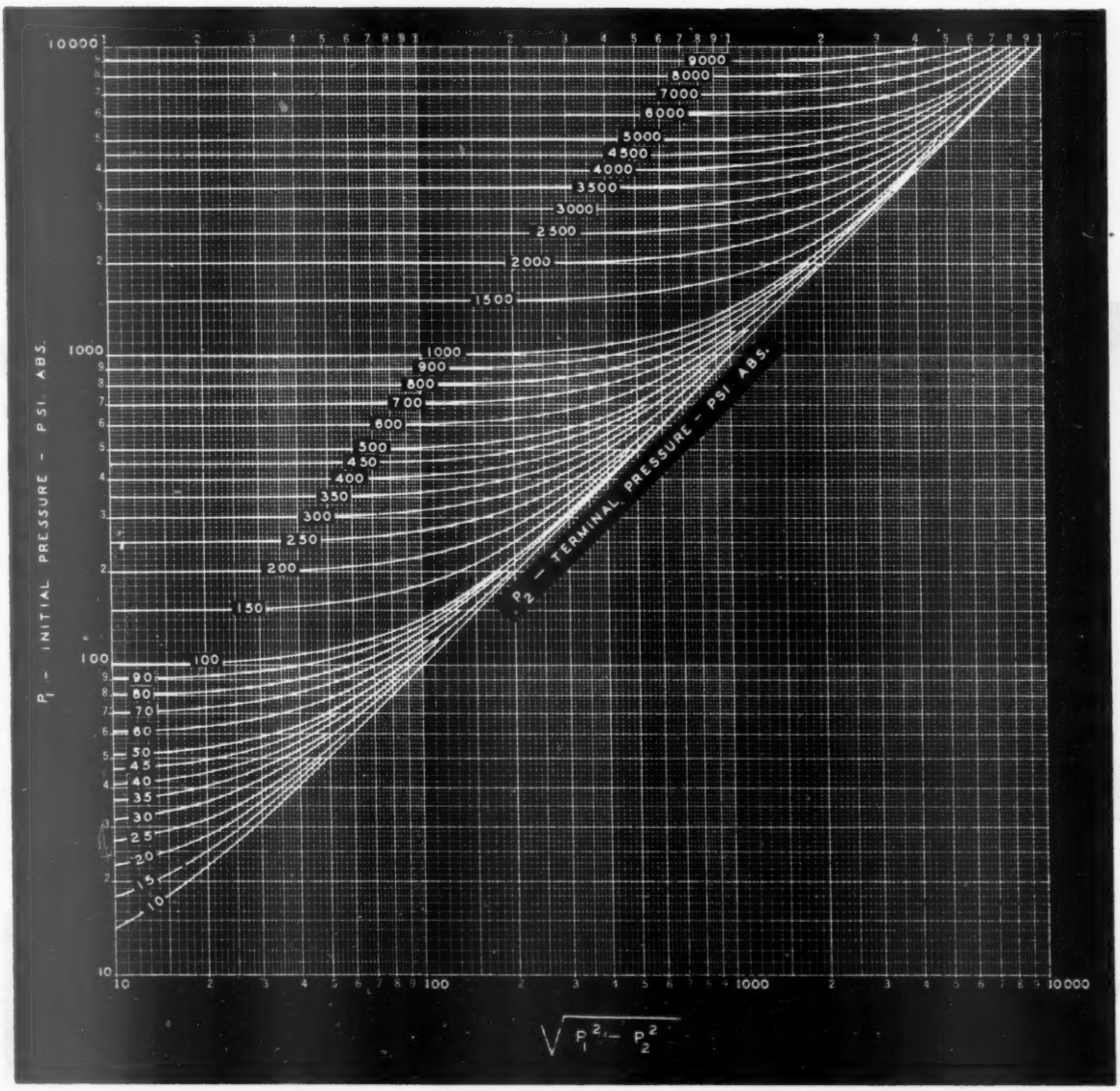
and obtaining the numerical values of the integrals from Clinedinst's charts:[1]

$$0.165 - \int_0^{P_{s_2}} \frac{P_s \, dP_s}{Z} = 0.09$$

$$P_{s_2} = 0.38$$

$$P_2 = 0.38 \times 672 = 255 \text{ psia.}$$

Fig. 9-1



In this case, the difference in outlet pressures as computed from the two equations is less than the error involved in reading the charts.

Comparison With Weymouth's Formula

Using Equation 9-4 for the solution of the foregoing example gives:

P_2 = 250 psia. (actual P_2 = 266 psia.)

which is only slightly lower than the previously calculated value using Equation 9-1. In this instance, the Weymouth friction factor differs from the friction factor read from the chart (Fig. 2-2) by less than 1 per cent. Since the deviation from an ideal gas is also small in this range of operating pressures, Weymouth's formula gives an outlet pressure only slightly less than Equation 9-1. At higher operating pressures, however, this difference becomes appreciable. Taking data on the Tennessee Gas & Transmission Corp. line[4] as follows: inlet pressure 774 psia.; outlet pressure 372 psia.; length of line 161.87 miles; the actual metered volume was 231,246 M.c.f./day. Calculating the flow rate by means of Equation 9-1:

Q = 222,000 M.c.f./day

which is in error by about 3.9 per cent with the actual measured volume.

Using the same data, Weymouth's formula gives:

Q = 209,000 M.c.f./day

which is approximately 10 per cent too low. In this instance, the friction factors are again in close agreement and the low result obtained by Weymouth's formula may be attributed to neglect of the compressibility factor. In recycling projects, where the deviation from an ideal gas is considerably larger because of the high operating pressures involved, neglect of the compressibility factor would lead to serious errors.

Notation:

C = $198.8 \div \sqrt{sfTL}$
d = differential operator
D = actual pipe i.d., in.
f = friction factor, dimensionless
L = pipe length, ft.
L_e = equivalent pipe length for computing effect of velocity head, ft.
P = pressure, psia.
P_R = pseudoreduced pressure
Q = flow rate M.c.f./day (14.7 psia. and 60° F.)
Re = Reynolds number, dimensionless
s = specific gravity of gas (air = 1.00)
T = temperature at flowing conditions, deg. Rankine
T_R = pseudoreduced temperature
Z = compressibility factor, dimensionless
μ_p = viscosity at flowing conditions, centipoises

Subscripts:
1 = conditions at entrance end
2 = conditions at outlet end

References

1. Clinedinst, W. O., "Flow Equations for Gas Considering Deviations from Ideal Gas Laws," The Oil and Gas Journal, Apr. 7, 1945.
2. Johnson and Berwald, "Flow of Natural Gas Through High-Pressure Transmission Lines," U.S.B.M. Monograph 6 (1935).
3. Miller, B., Trans. A.I.Ch.E., 32, 9 (1936).
4. Federal Power Commission Docket G-621, Exhibit to Application 2, T. G. & T. Co. Reported by Grizzle, B. F., Petr. Engr., Sept. 1945.
5. Weymouth, Trans. A.S.M.E. 34, 197 (1912).
6. Brown, G. G., "Natural Gas Under Pressure," Proc. 19th annual convention N.G.A.A., May 1940.

Robert H. Reeves, who was a first lieutenant in the Army Air Forces, has returned to his job as scout for Union Oil Co. of California at Midland, Tex.

Fladger F. Tanner, formerly a member of the University of Texas faculty, has been made general auditor for Humble Oil & Refining Co. in Houston.

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Increasing Rates of Depletion

*by Park J. Jones**

Part 16 of a Series

DECLINING rates of production may be accompanied by increasing, uniform, or decreasing rates of of depletion. Cycling operations and pressure maintenance projects are usually conducted at increasing rates of depletion. The rate of depletion, at the time the rate of production from a reservoir starts declining, is equal to the ratio of cumulative recovery and the product which results when reserve is multiplied by the number of years during which the recovery was accumulated. If the subsequent rates of depletion are uniform, this ratio is also equal to the prospective rate of production decline. But if the subsequent rates of depletion are not uniform, the prospective rates of production decline are variable. Variable rates of depletion are either increasing or decreasing rates of depletion. This article defines the limiting rates of production which represent increasing rates of depletion. The optimum rate of production for increasing rates of depletion is different from the optimum rate of production for decreasing rates of depletion. For this reason, it is desirable to define the rates of production which represent increasing rates of depletion.

Initial Rate of Production Decline

SUPPOSE a fraction "a" of an initial reserve is accumulated at the time production starts declining. Then the reserve is (1 — a) M.c.f.'s per M.c.f., or barrels per barrel, of initial reserve. Let Q denote the rate of production at the time production starts declining. The equivalent life of the accumulated production is equal to a/Q. Let y equal a/Q. Then y years are required to accumulate a reserve "a" at a uniform, or average, rate of production Q. Now, the rate of depletion R, at the time production starts declining, is equal to the rate of production a/y divided by reserve (1 — a), that is,

$$R = \frac{a}{(1 - a)y} \qquad (1)$$

*Production consultant, Houston.

Consider a uniform rate of depletion. If the rate of production, at the time production starts declining, is proportional to reserve; the rate of production decline D is equal to the rate of depletion R. So

$$D = \frac{a}{(1 - a)y} \qquad (2)$$

The curves in Fig. 16-1 are solutions of Equation 2. The annual rate of production decline D in per cent is plotted against the number of years during which a fraction "a" of initial reserve was accumulated. These data are for uniform rates of depletion only. The rate of production decline relative to variable rates of depletion will be considered later. We might note, however, that the curves in Fig. 16-1 define the rate of depletion at the time production starts declining.

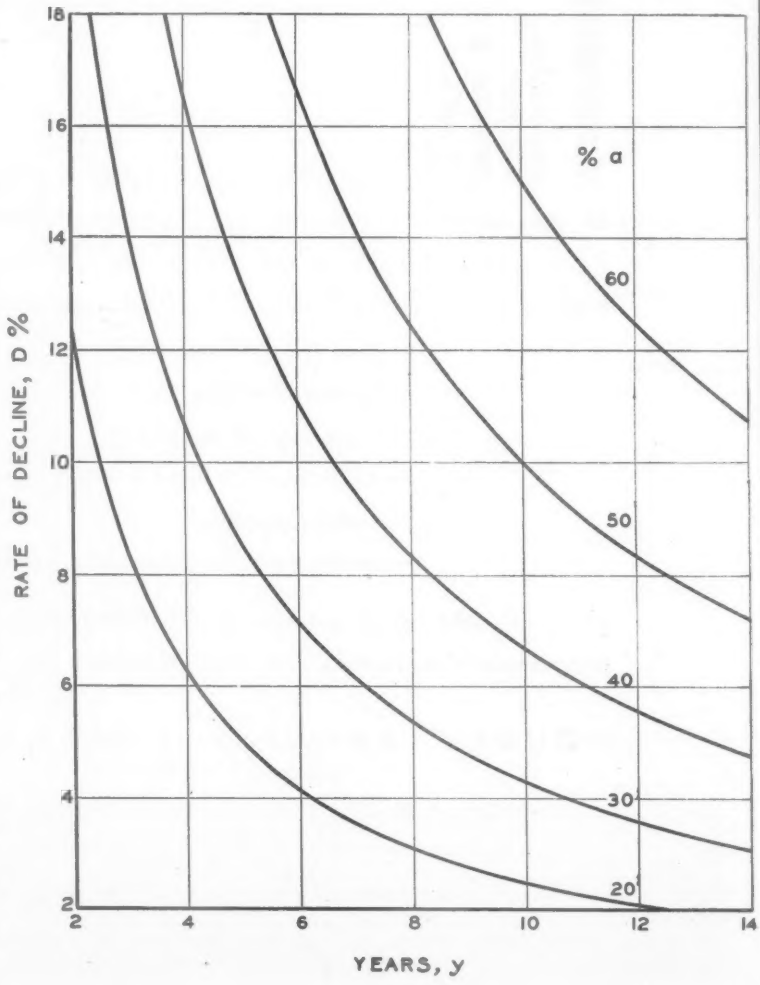


Fig. 16-1—The rate of production decline after y years during which "a" per cent of reserve is accumulated; the data are either the rate of decline in per cent per year for uniform rates of depletion or the rate of depletion in per cent per year of reserve at the time production starts declining

A Natural Gas Reservoir

The rate of production from a natural gas reservoir starts declining when the accumulated recovery is 40 per cent of the initial reserve. The rate of production is 10 per cent per year. Estimate the rate of

depletion. **Solution:**—In this example, the equivalent life for the accumulated recovery is 40/10 or 4 years. From Fig. 16-1, corresponding to 40 per cent recovery and a 4-year equivalent life, the rate of depletion is 16.6 per cent.

An Oil Reservoir

The rate of production from an oil reservoir starts declining when the accumulated recovery is 50 per cent. The rate of production is 5 per cent per year. Estimate the rate of depletion. **Solution:**— In this example, the equivalent life of the recovered reserve is 50/5 or 10 years. From Fig. 16-1, corresponding to a 50 per cent cumulative recovery and a 10-year equivalent life, the rate of depletion is 10 per cent.

A Cycled Condensate Reservoir

The rate of production from a cycled condensate reservoir starts declining when the cumulative recovery is 60 per cent. The rate of production is 7 per cent per year. Estimate the rate of depletion. **Solution:** In this example, the equivalent life is 60/7 or 8.6 years. From Fig. 16-1, the rate of depletion is 17.5 per cent.

In the foregoing examples, the solutions are for the initial rates of depletion. Subsequent rates of depletion may be either uniform or variable. The corresponding rates of production decline are either uniform or variable.

Rate of Production vs. Time

Consider a uniform rate of production equal to Q M.c.f.'s per M.c.f., or barrels per barrel, per year of initial reserve. For example, a 10-per-cent-per-year uniform rate of production plotted against time is a horizontal line as shown in Fig. 16-2. On the other hand, consider a uniform rate of depletion. The corresponding rate of production is defined by

$$Q = Re^{-Rn} \qquad (3)$$

where R is a uniform rate of depletion. For example, the rate of production corresponding to a 10 per cent per year uniform rate of depletion is illustrated by Curve 2 in Fig. 16-2.

A declining rate of production for increasing rates of depletion would fall between Curves 1 and 2 in Fig. 16-2. The rates of production corresponding to increasing rates of depletion are less than uniform rates of production and greater than the rates of production corresponding to uniform rates of depletion.

Rates of Depletion vs. Time

Consider a uniform rate of production Q M.c.f.'s per M.c.f., or barrels per barrel, per year of initial reserve. The corresponding rate of depletion R is defined by

$$R = \frac{Q}{1 - Qn} \qquad (4)$$

where n is time in years. Curve 1 in Fig. 16-3 is a solution of Equation 4 for a 10 per cent per year uniform rate of production. Rate of depletion, in per cent per year of reserve, is plotted against time in years. On the other hand, a 10 per cent-per-year uniform rate of depletion plotted against time is a horizontal line as shown in Fig. 16-3.

Consequently, increasing rates of depletion for declining rates of production, are less than the rates of depletion corresponding to uniform rates of production and greater than uniform rates of depletion.

Rate of Production vs. Cumulative Recovery

The relationship between the rate of production and cumulative recovery for a 10 per cent uniform rate of production and a 10 per cent uniform rate of depletion is illustrated by the data in Fig. 16-4. We might note that these data are represented by straight lines. These relationships are defined by

$$Q = R_o(1 - C)^p \qquad (5)$$

where R_o is the rate of depletion at the time production starts declining. The exponent p depends on producing and operating methods. For uniform rates of production, p is equal to zero. For uniform rates of depletion, p is equal to one.

Consequently, the value of p for increasing rates of depletion is greater than zero but less than one. Increasing rates of depletion fall between the two straight lines in Fig. 16-4. The curves in Fig. 16-5 are illustrative examples. Rates of pro-

Fig. 16-2—Rate of production in per cent per year of initial reserve vs. time in years for (1) a 10 per cent per year uniform rate of production and (2) a 10 per cent per year uniform rate of depletion

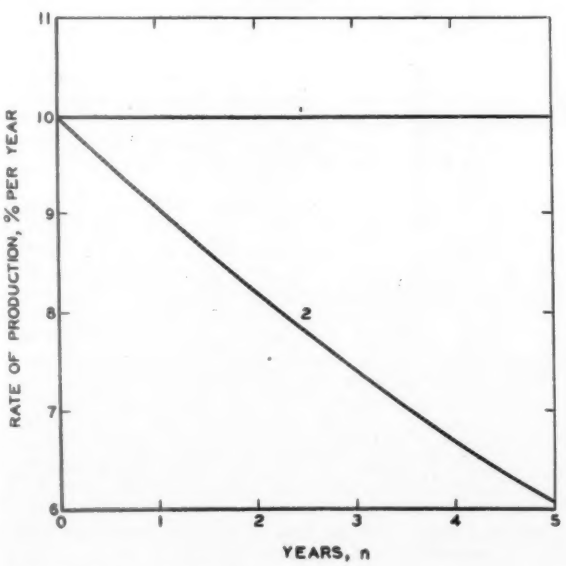
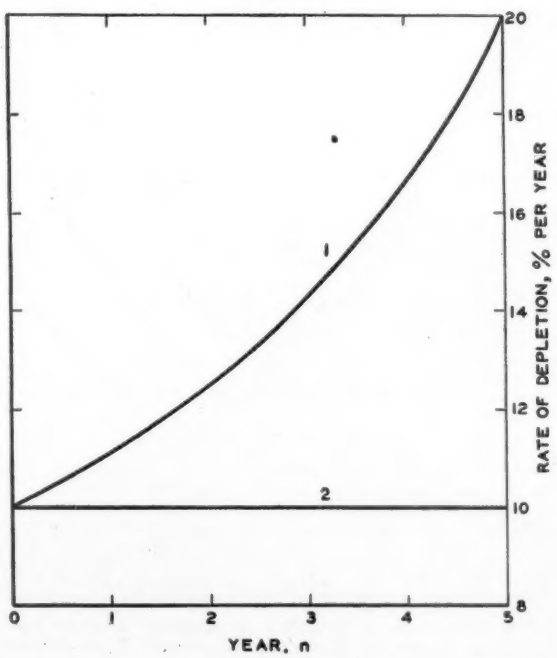


Fig. 16-3—Rate of depletion in per cent per year of reserve vs. time in years for (1) a 10 per cent per year uniform rate of production and (2) a 10 per cent per year uniform rate of depletion



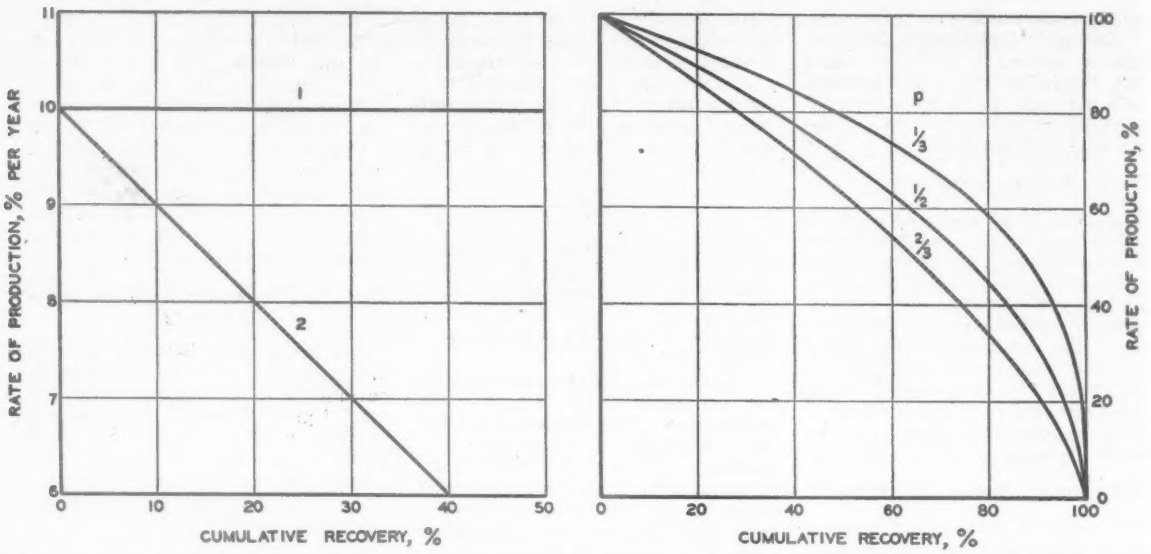


Fig. 16-4—(Left) Rate of production in per cent per year of initial reserve vs. cumulative recovery in per cent of initial reserve for (1) a 10 per cent per year uniform rate of production and (2) a 10 per cent per year uniform rate of depletion. Fig. 16-5 (Right) Rate of production in per cent of the initial rate of production vs. cumulative recovery in per cent of the reserve recoverable at declining rates of production but increasing rates of depletion

duction in per cent of the initial rate of production are plotted against cumulative recovery in per cent of initial reserve.

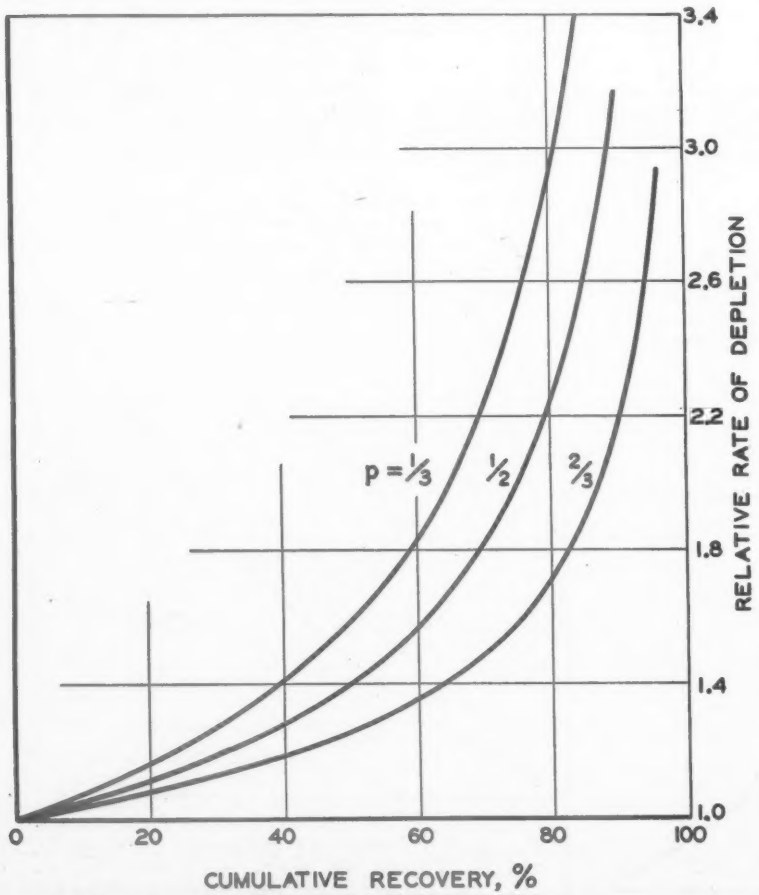


Fig. 16-6—Relative rate of depletion vs. cumulative recovery and exponent p; cumulative recovery in per cent of the reserve recoverable at declining rates of production

The Relative Rate of Depletion

The rate of production Q at any time is equal to the rate of depletion R times the reserve (1 — C). that is,

$$Q = R(1 - C) \qquad (6)$$

Upon eliminating Q between Equations 5 and 6, we obtain

$$R = R_o(1 - C)^{p-1} \qquad (7)$$

The initial rate of depletion is defined by Equation 1. Denote the initial rate of depletion by unity. Then the relative rate of depletion is given by

$$R = (1 - C)^{p-1} \qquad (8)$$

The curves in Fig. 16-6 are illustrative examples. Relative rates of depletion are plotted against cumulative recovery. These data represent increasing rates of depletion. The production characteristics for these rates of depletion will be considered in the next article.

Lt. Gen. James H. Doolittle, who led the first air attack on Tokyo, will leave the Army Air Forces January 1 to become vice president of Shell Oil Co., Inc. He will have "general corporate responsibilities," the company announced, including coordination of Shell's aviation interests in the United States, and will assist in its worldwide aviation activities. His office will be in New York. General Doolittle had been manager of Shell's aviation department for 10 years when he was recalled to active Army duty in 1940. At the time of the Tokyo raid he was a lieutenant colonel.

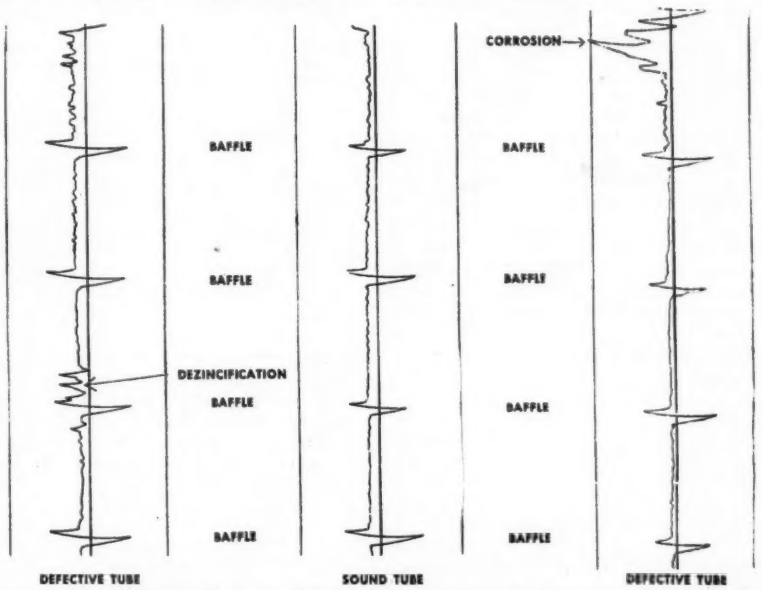
Probolog Spots Corrosion, Cracks, Holes in Exchanger Tubes

DETERMINATION of irregularities electrically in exchanger and other nonferrous tubes is the most recent accomplishment by Shell Development Co. engineers. By passing a "feeler" or probe through the tube throughout its length, pits, holes, cracks, thin spots, and other damaged conditions are registered on a moving paper ribbon to show the condition of the tube and warn of the need for replacement. In the great majority of cases these bad conditions are discovered and proved long before the naked eye can discover them, say the Shell engineers responsible for this newest development.

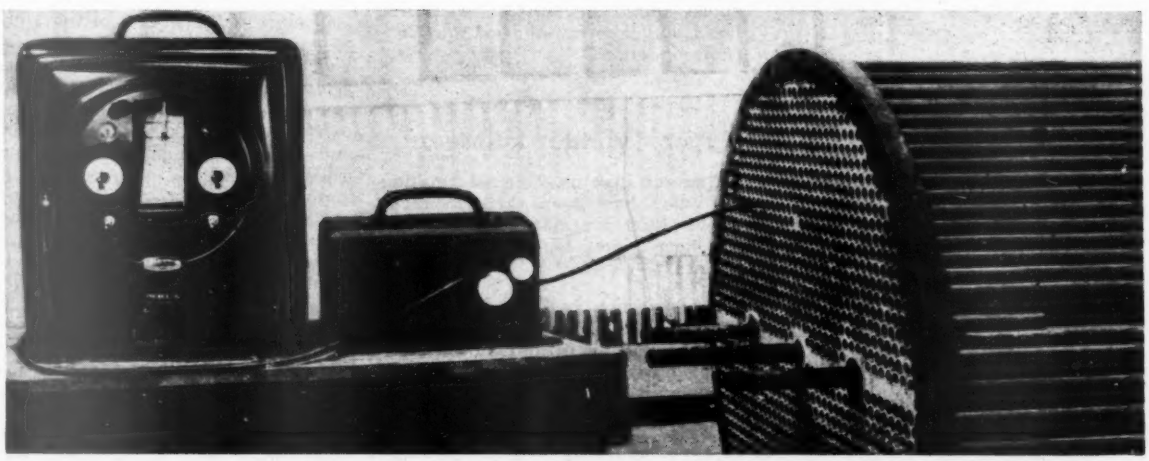
The Probolog includes the probe, a plug-type instrument slightly smaller in diameter than the tubes to be tested with it. The probe's mechanical construction is not disclosed in detail but includes electrical coils of a specific type. This probe is pulled through each tube in the bundle, either by hand for preliminary inspection or by a specially constructed puller, electrically driven at a standard rate. The electronic recorder is essentially a Wheatstone bridge, of which assembly the tube under test becomes a part; to this is added mechanisms for passing a strip chart of paper, and an inking pad for recording the mark which becomes a record of the tube's condition.

In inspecting a set of tubes in a bundle, a neon flasher is connected to the electronic instrument, and the probe, connected to the machine by an insulated electric cord, is passed by hand rapidly through each tube in turn. The neon light flashes with varying degrees of intensity as irregularities on the tube wall are passed; the instrument actually shows differences in the thickness and condition of opposite points in the tube wall. Tubes showing severe conditions of corrosion, etc., are marked for more careful investigation later. For this detailed study and record the recording apparatus is activated in the system and as the probe is pulled through the tube at a standard, predetermined rate the pen, actuated by variations in the balance of the Wheatstone bridge records the imperfections, making a smooth line when the tube is perfect. By this system it can be determined exactly which tubes are leaking, seriously corroded, and need replacement. The Probolog operates on standard 110-volt, alternating current, a 60-cycle current, and needs no other connection to power source. The present model is designed especially to test nonferrous metal tubes. On the record wide swings of the recorder are caused by baffles, the thicker tube sheet showing correspondingly wider swings, as shown in the accompanying sample records.

The instrument is available for sale to the industry.



Typical Probolog records of actual tubes from an isobutane column condenser. On the left is the log of a defective tube from the upper or "hotpass" in which dezincification was found by check inspection to have taken place in area indicated. Record on right is that of a tube from lower or "cold pass" showing severe corrosion near one end but a satisfactory condition throughout rest of its length



The Probolog at work in the refinery, testing heat-exchanger tubes

QUESTIONS on TECHNOLOGY

by W. L. Nelson
Consulting Engineer

This department was created for the purpose of aiding managers, superintendents, engineers, chemists and all those engaged in various phases of plant operation, as well as those connected with the marketing and utilization of petroleum products. Readers are invited to submit their problems to W. L. Nelson, technical editor. Inquiries must be signed, but only the initials will be printed.

Economic Approach In Condensers

In Petroleum Refinery Engineering, page 658, you present data on the most economical approach for liquid-to-liquid heat exchangers. Would the economical approach for condensers be the same or would it be different because of the heat of condensation?—P. A. B.

Attempts to develop a mathematical relationship for condensers such as that referred to above is extremely difficult but condensers may be handled by means of an equivalent ratio of fluids as developed below. It is easily seen that a material that condenses behaves as if it were a much larger quantity of liquid that does not condense. In other words, cooling of it does not cause its temperature to decrease as much as it would if it were a liquid that was not condensing. Mathematically for a noncondensing material:

$$WC\,(T - x) = wc\,(y - t)$$

in which W and C are the pounds and specific heat of a high-temperature liquid as it is cooled from T to x, and wc is the pounds times specific heat of a low-temperature liquid being heated from t to y. Thus, the ratio of fluids may be defined as:

$$R = \frac{WC}{wc} = \frac{y - t}{T - x}$$

Similarly for a condensing material, in which L is the latent heat:

$$WC\,(T - x) + WL = wc\,(y - t)$$

$$WC\left[(T - x) + \frac{L}{C}\right] = wc\,(y - t)$$

$$\frac{WC}{wc}\left(1 + \frac{L}{C\,(T - x)}\right) = \frac{y - t}{T - x}$$

$$R\left(1 + \frac{L}{C\,(T - x)}\right) = \frac{y - t}{T - x}$$

Thus, R′ which may be defined as the "equivalent ratio" of fluids when one of the fluids totally condenses (or vaporizes), may be defined in terms of the regular R as:

$$R' = \left(1 + \frac{L}{C\,(T - x)}\right) R$$

and the equivalent ratio may be used on the chart found in Petroleum Refinery Engineering.

One other difficulty arises. The ratio of fluids R is always based on the larger fluid divided by the smaller fluid so that it always has a value less than 1. In a condenser, the small-volume fluid may behave as if it were the large-volume fluid because of the large amount of heat required for condensing. Thus, the formula shown above may be employed if the value of R′ is less than 1, but if it is larger than 1, its reciprocal should be used:

$$R' = \frac{R}{1 + \dfrac{L}{C\,(T - x)}}$$

Finally, if the material does not completely condense at the approach temperature found, the L in the above equations should be multiplied by z which is defined as the fraction condensed.

Upper Cylinder Lubricant

Can you give us some information on what has been written about upper lube for automotive trade, and how it may be tested for effectiveness?—A. M.

Much verbal controversy over the effectiveness of top cylinder lubricants occurs but little has been published on the subject, nor are there any simple tests that are of much significance in judging such an additive. Perhaps the best general reference concerning the claims that sellers make for lubricated gasolines is "A Protest of Revised Maximum Price Regulations" presented before the Office of Price Administration by Lubri-Gas Laboratories of Chicago. In addition, a few discussions have appeared in The Oil and Gas Journal: (1) December 8, 1931, p. 28; (2) Conine, December 29, 1932, p. 9; (3) Lubricated Gasoline, June 19, 1941, p. 61; (4) A Gasoline Additive, October 30, 1941, p. 46; (5) Gum Content of Lubricated Gasolines, April 2, 1942, p. 43, and (6) Oil Used in Lubricated Gasolines, May 27, 1943, p. 74.

Gum in Diesel Fuels

What is the situation with respect to the gum content of diesel fuel oils? We are planning on using cracked distillate in our diesel fuel oil.—A.G.M.

To our knowledge no formal action regarding gum content or specifications for gum have been evident, but interest is continually being evidenced, particularly in the development of test methods. Only the specifications of Hercules Engine Co. contains a gum specification. They specify 75 mg. maximum gum in 1,000 ml. (1944).

Although a lack of stability during storage is a serious matter because the refiner has little control over such conditions, the presence of performed gum at the moment of test would not seem to be very important because its presence (or its effect) would be included to a large extent in the carbon residue test which is common in diesel fuel specifications.

The evaporation of diesel fuels, without decomposition, for the evaluation of gum is difficult because of the high boiling-range of such materials. Dickey & Henry (Gum Content of Distillate Diesel Fuels, I. E. Ch. Anal. Ed. 16, 710, 1944) resort to the use of both a vacuum (500-550 mm.) and a stream of inert gas, to accomplish the evaporation, as well as employ a high temperature. Finally, the residue of gum contains so much high-boiling oil that it must be treated with carbon tetrachloride and acetone (which is also evaporated) in order to gain consistency in the results. For stability in storage these authors recommend an accelerated test similar in most important respects to the U. S. Government test for aviation fuels. This consists of producing gum in a 200-ml. sample contained in an 8-oz. sample bottle by holding it for 5 hours in a bomb under a pressure of 100 psi. at 212° F. in the presence of iron and brass catalysts. One hundred square centimeters of polished brass and of polished iron were used in each sample bottle.

Design and Operation Of Abercrombie Plant

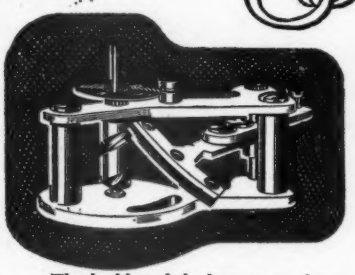
(Continued from page 90)

tion tower, tar is knocked down to the bottom of this side tower and the clean oil is vaporized back to the main tower base to join the main body of the oil. At a point about one-third of the distance down from the main tower top, about the eighth tray, a side stream is withdrawn, stripped in a four-tray stripper and sent to storage as a kerosene cut. The lean oil withdrawn finally from this tower bottom is therefore stripped continuously of the tar formed during the cycle, is reduced to a high initial boiling point and goes to storage or returns to the system as required for the first 4 or high-pressure absorbers as outlined above.

Vapors and liquid accumulators from the intermediate and high-pressure stills are interconnected, so that the fractions obtained overhead are passed through heat exchangers and into the depropanizer tower about midway, at approximately 335 psig. According to design the propane stream overhead from this tower is a little less than 1,000 bbl. per day. The propane-free bottoms go direct after stripping to the debutanizer tower into which it is flashed at 85 psig. near the middle of the tower. The overhead is mixed butanes which is condensed and transferred at the same pressure to the isobutane or "butane splitter" tower of 50 plates which sends isobutane vapors overhead, approximately 95 per cent pure; normal butane is taken from this tower bottom about 96 per cent pure, which may be disposed of as such or blended with pentanes and heavier as natural gasoline.

The bottoms from the debutanizer tower, containing pentanes and heavier, is flashed in the deisopentanizer tower at about 30 psig. at any one of three points located at the 34th, 30th and 26th trays. Overhead is taken 95 per cent pure isopentane, about 500 bbl. per day according to design. The bottoms from this tower exchange heat with the raw gasoline entering the depropanizer, pass through a cooler and to storage, a gravity of about 70° A.P.I. being typical.

The compositions of the raw incoming gases are shown in Table 1. The calculated weighted average composition of butanes and heavier is 0.85 gal. per 1,000 cu. ft. from the entire indicated gas production. Although the highest-pressure gas is relatively lean, the quantity of that gas is so great that more than half the total gasoline production is from the 2,250 psig. stream.



The highly polished contact surfaces of the graphited Bakelite cam and the bronze helicoid roller account for the unusual wearing qualities of the Helicoid movement.

75 million is a lot of anything. And when any pressure gage withstands 75 million cycles of operation, that represents a lot of gage service.

To determine how much longer Helicoid Gages with Helicoid movements would wear than ordinary gages with spur geared movements, an endurance test was run by an independent testing laboratory.* Two of the best spur-geared movement gages were tested against Helicoid Gages.

All gages were pulsated at the rate of 1200 cycles per minute. One gage failed after 500,000 cycles because the stainless steel teeth were worn away. The other gage failed after 10,000,000 cycles. After 75,000,000 cycles (as of Sept. 5, 1945), the two Helicoid Gages were still operating, and were within an accuracy of ½% and 1% respectively.

This proves that the Helicoid movement greatly outwears spur geared movements and that Helicoid Gages remain accurate long after ordinary gages are worn out.

If your service cost on pressure gages is high, it will pay to switch to Helicoid Gages.†

*U. S. Testing Co., Inc., Hoboken, N. J. See report 42592.

†Formerly called "Certified."

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Latest Equipment Expedites Construction of Loop on Panhandle Eastern Line

by Paul Reed

IN laying two loop lines consisting of 32 miles of 24-in. for Panhandle Eastern Pipe Line Co. in Indiana and Ohio, the contractor utilized a recently developed cleaning machine and improved pressure-welding facilities.

One loop was laid from the Salamonie River to a point near Bluffton, Ind.; the second loop ran from a point near Paulding to a point near Defiance, Ohio. There were two creek crossings and a crossing at the Maumee River. The project was part of an expansion program of the Panhandle Eastern company for increasing capacity by 50,000,000 cu. ft. daily through the installation of additional compressor units at various stations as well as by the building of this loop.

Wrinkle bending was done with Crutcher-Rolfs-Cummings mechanical equipment of the type widely used in building the Tennessee Gas & Transmission Co. system last year.

Welding of the Panhandle Eastern loop has been a good example of what can be accomplished with the pressure-welding process. Improved pressure-welding clamps now provide for simpler and more automatic operation. Speedier and more accurate alignment of the pipe in the machine has been accomplished by holding to close tolerances the parts functioning in connection with operations for gripping the pipe. The upset produced during welding is controlled within narrower limits by means of electric-switch equipment which automatically releases hydraulic pressure from the "endo" cylinders, thus producing uniform welds.

At the beginning of this looping project, which was constructed of 24-in. o.d. pipe with 9/32-in. wall thickness, adjustment of the flame was made by a process service engineer. This adjustment proved to be an important factor in attaining good welding efficiency since the operators complied with his initial instructions during the remainder of the job.

Every morning a test weld was made before the day's operations commenced. Coupons were cut for subjecting to tensile, bend, and nick-break tests by equipment carried to the location. By this procedure, it was possible to maintain a high degree of excellence throughout the day's work. Welding was done at an

average rate of seven to eight welds per hour. On some unusually good days there were 10 welds per hour.

Much time was lost because it was necessary to hammer the ends of joints to put them in shape for proper alignment. The flattening of the joints has been traced to the period during which the pipe was in transit by railroad from the mill. The round shape might have been protected if plugs had been inserted in pipe ends where they would remain until joints would be aligned for welding.

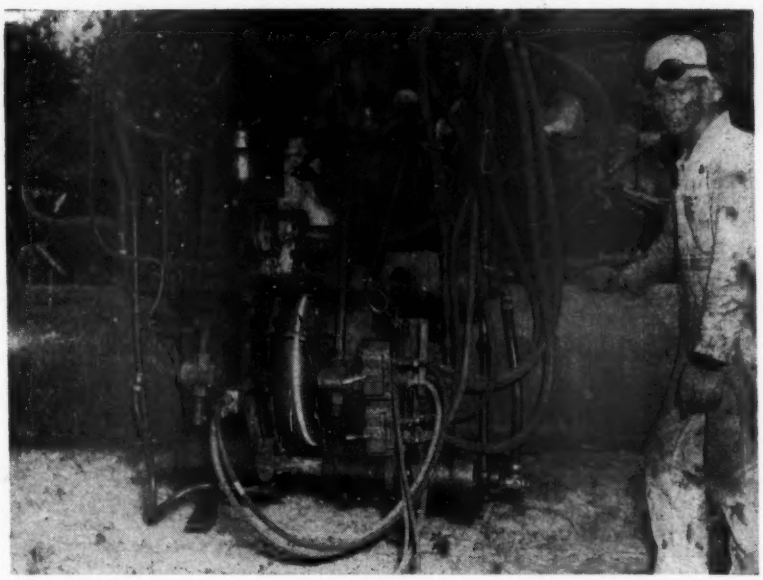
Close attention was given to insuring that dirt was entirely removed from the ends of joints before alignment in the clamps. Care and skill of the operators were essential for obtaining good results. The operators were obtained from Pressure Weld Co. and it maintained a service man at its own expense. Pressure-weld equipment was rented to the contractors laying the lines.

In testing, completed sections of line were filled with natural gas and exceptional tightness was found.

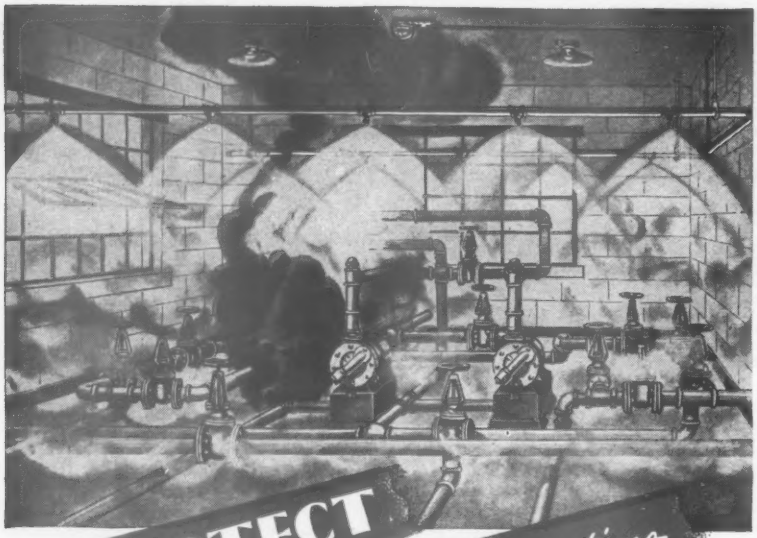
The mechanical equipment used for cleaning and priming for the job is an improved unit. Cleaning is done by buffer-type operation. A frame with cylindrical brushes revolves clockwise while the individual brushes revolve counter clockwise.

The pipe was coated for its entire length with enamel. Part of the line was wrapped with asbestos pipeline felt.

The construction of the Panhandle Eastern loop has demonstrated what can be accomplished with certain equipment and material representing important recent advances.



Below: Pressure welding unit being raised from pipe after completing a weld on loop laid by Midwestern Constructors for Panhandle Eastern Pipe Line Co. Right: Close-up view of pressure-welding unit on 24-in. line



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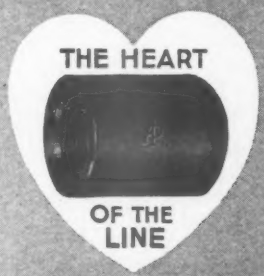

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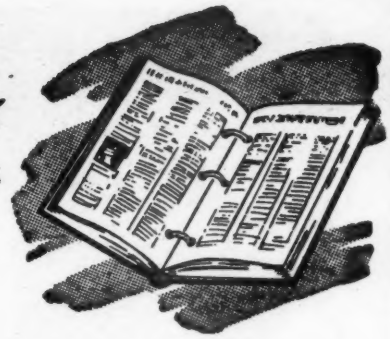
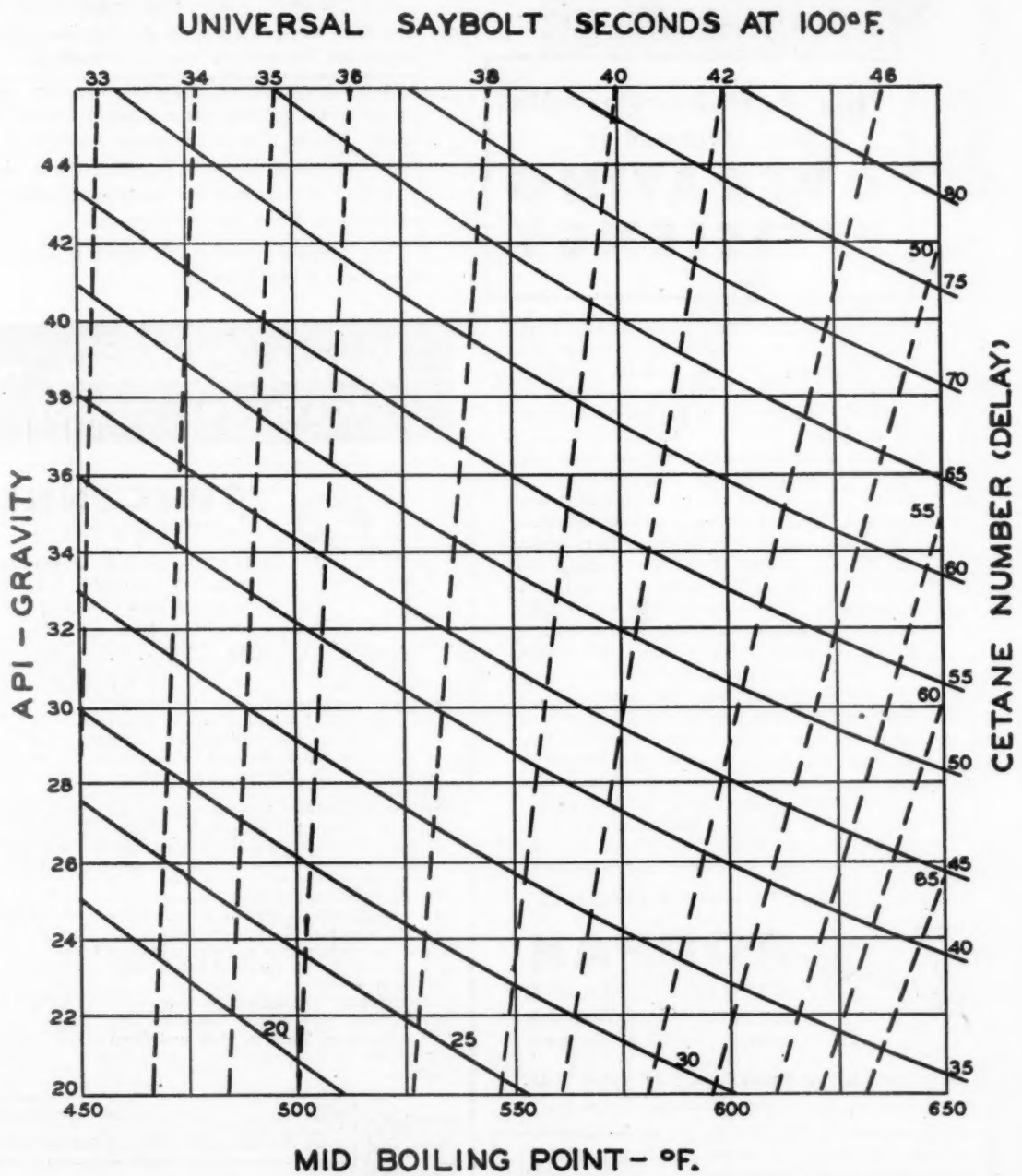


Evaluation of Diesel Fuels



No. 72 in a series by W. L. Nelson, professor of petroleum refinery engineering, University of Tulsa

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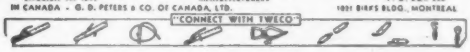


Staking Foundations and Setting Batter Boards

FOUNDATIONS for buildings to house pumps, generators, engines, and for storage, living quarters, field offices, etc., are designed for uniformly distributing the weight of the structure in a fixed position. Concrete blocks often are used for this purpose when readily available. Most common method, however, is the construction of monolithic concrete foundations. Laying or "staking out" is the fixing of reference lines to set the position of the foundation and outside walls in true alignment and elevation.

The stakes and lines may be laid out either by "squaring" or with a surveying instrument. For simplier foundations of rectangular shape the squaring method can be done in a few minutes time (Fig. 1). First, a base line is established which locates one side or end. Two stakes, A and B, are driven to position this side. A nail is driven into the center of the top of each stake to permit the measurement to be made to an exact point. Under the string line between stakes A and B a third stake, F, is driven exactly 6 ft. from A. On a line perpendicular to that between A and B, a fourth stake, E, is driven so that its distance will be exactly 8 ft. from A and 10 ft. from F. These measurements, of course, establish a right-angle triangle, and thus assure that the line AE is perpendicular to the line AB.

This operation is repeated at each corner until all sides have been staked. An alternative to the procedure of setting "right angle" stakes for each corner is to construct a large layout square with the right-angle legs AF and AE being 6 and 8 ft. long, respectively, and the hypotenuse EF equaling 10 ft. The layout square is positioned at corners A, B, C, and D so as to permit the obtainment of right angles where the guide strings are to cross.

The batter boards (Fig. 2) are constructed outside of the excavation lines and the excavation and building-line strings are held by means of slits cut into the boards.

Building foundations.—Footings for houses and buildings must be adequate to prevent settling and should be deep enough not to be subject to freezing and thawing of the ground upon which they rest. While the exact width and depth of the footings depend upon the size of the building and the weight to be carried, the details shown in Fig. 3 present a general idea of various practices.

Walkways and steps.—Setting of forms for walkways is the easiest phase of concrete construction, involving no more than correct alignment and elevating of the boards to form the sides. Construction of steps which may be necessary along some portions of the walk is more difficult. The notching of stringers and attaching of tread strips by nailing can be dispensed with by using the novel arrangement shown in Fig. 4.

References

*"1,001 Ways to Use Concrete," by H. O. Hayes.

†"Builders Guide," Vol. 3, by F. D. Graham and T. J. Emery.

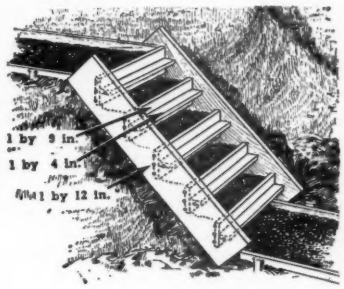


*Fig. 4—(Above) Form for concrete steps**

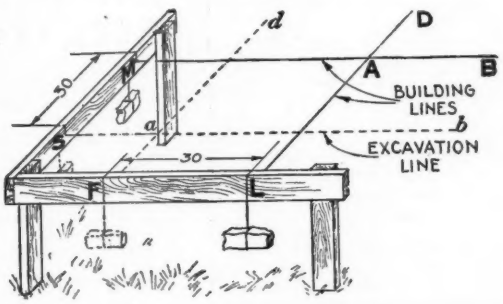


Fig. 2—(Left) Details of batter boards†

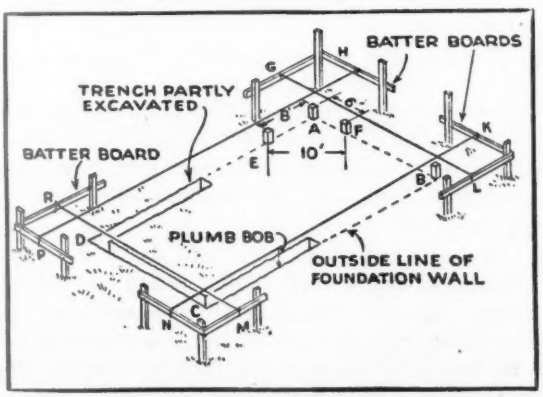


*Fig. 1—Laying out foundations**

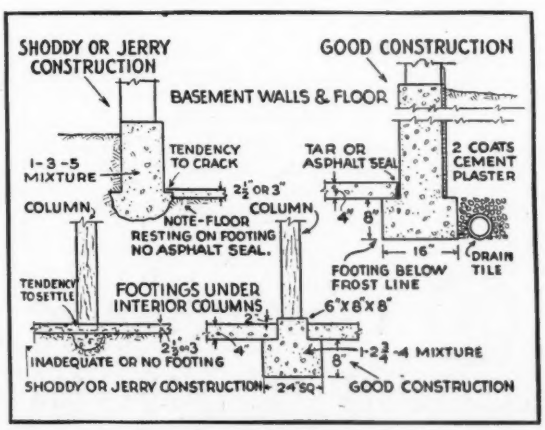
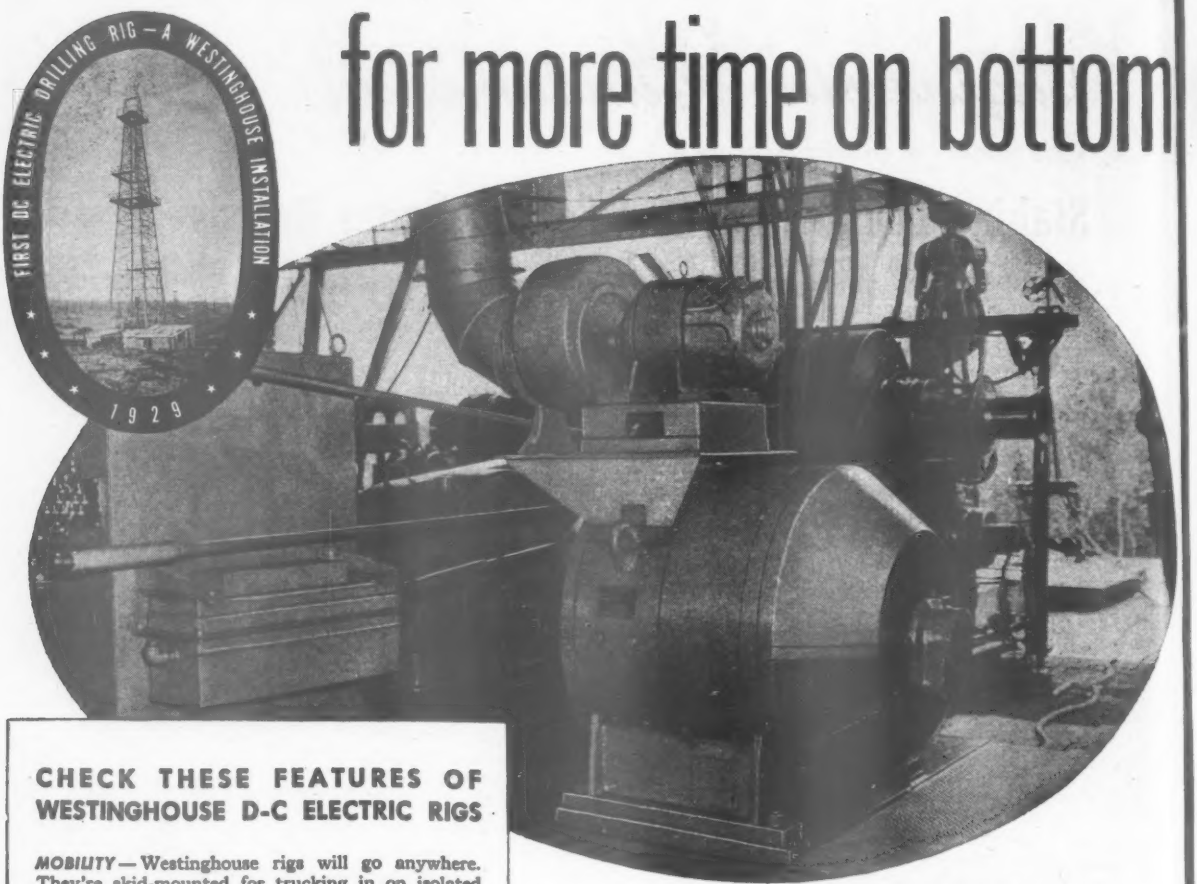


*Fig. 3—Details of footings**

for more time on bottom



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Natural Gas

Texans Urged to Conserve Their Gas Resources

SAN ANTONIO. — Texas has it within its power to become the major industrial center of the United States if its people have sufficient vision to conserve the state's natural-gas resources, Sam Houston Jones, former governor of Louisiana, declared in an address before a meeting of Rotarians here last week.

"Unless Texas, Oklahoma, Arkansas, and Louisiana save their natural gas, their hope for industrialization is gone," the speaker declared.

Urging his hearers to "stop the exploitation of Texas' natural-gas resources," Jones warned that unless the present movement of shipping natural gas out of the state is retarded within the next 2 years, the state's chances of becoming an industrial empire will vanish.

"The state's natural gas resources will be tied up in long-term contracts consigned to eastern industrial areas if the mad scramble to build pipe lines out of the state in every direction is continued," said Jones. "If this brazen, ruthless and fantastic plan is carried out, we may even see the people of the East burning Texas gas from converted reservoirs, long after this state's gas fields are empty and abandoned."

Northern Natural Planning To Meet Winter Needs

CHICAGO.—At a hearing in this city on an application of Northern Natural Gas Co. testimony was received showing that company's need for additional facilities in order to meet winter requirements of customers in Iowa, Kansas, and Nebraska. Total cost of proposed construction is estimated at $1,407,748. Authorization was asked for the following projects:

1. Construction of approximately 20 miles of 20-in. loop line in Iowa, extending north from Natural's Ogden compressor station at an estimated cost of $469,417.

2. Construction of about 10 miles of 24-in. loop line in Kansas extending northeasterly from a point about 24 miles northeast of the company's Mullinville compressor station in continuation of an existing loop line at an estimated cost of $291,043.

3. Construction of 7 miles of 24-in. loop line extending northeasterly in continuation of an existing loop in the vicinity of the Bushton compressor station at an estimated cost of $213,099.

4. Construction of about 13½ miles of 24-in. line extending southwesterly from the company's Beatrice compressor station at an estimated cost of $434,189.

State Corporation Commission of Kansas, Michigan-Wisconsin Pipe Line Co., western railroads, and several coal companies were permitted to intervene.

Applications filed under several dockets which were consolidated and originally set for hearing on November 28, requested authorization for construction of other facilities, including two new compressor stations, four compressor units to be installed in existing compressor stations, and a number of loop lines in Kansas, Nebraska, and Iowa. At the request of interveners FPC postponed the consolidated hearing and will fix a date later. The Chicago hearing was confined to facilities described by the company as necessary to meet an emergency situation this winter.

United Permitted to Move More Gas From Carthage

WASHINGTON. — By modifying and amending the original certificates of convenience and necessity issued July 5, Federal Power Commission has authorized United Gas Pipe Line Co. to transport a maximum of 172,000,000 cu. ft. of natural gas per day from the Carthage, Tex., field to the Monroe, La., field to serve its present customers, Memphis Natural Gas Co., Southern Natural Gas Co., and Mississippi River Fuel Corp., and to United Gas Corp. for resale in Calhoun, La. This is in addition to the 114,000,000 cu. ft. which United was originally authorized to transport for the Tennessee Gas & Transmission Co. over the Carthage-Sterlington pipe line. According to the company's application, the transportation of natural gas from the Texas field is necessary to obtain a new source of supply as its reserves in the Monroe field decline.

The certificate of July 5, authorized United to construct the 143-mile 24-in. Carthage-Sterlington line for Tennessee Gas & Transmission Co., and to transport through it a maximum of 114,000,000 cu. ft. of gas a day from Carthage field to Tennessee's Monroe compressor station and to transport during the war emergency period a maximum of 65,000,000 cu. ft. a day to United's present customers. This is increased now to 172,000,000 cu. ft.

Through additional firm contracts, United has increased its reserves in the Carthage field from 1,000,000,000,000 cu. ft. available to it at the time the original certificate was issued, to 1,985,583,000,000 cu. ft., or an equivalent of 30 years' supply at the proposed rate of withdrawal, and in addition is negotiating for further reserves.

Hearing in Rate Case to Be Resumed January 7

WASHINGTON.—The rate hearing in the case of Pittsburgh & West Virginia Gas Co. and Kentucky-West Virginia Gas Co., previously set for December 3, has been postponed to January 7. The investigation is the result of a complaint filed by the city of Pittsburgh on March 17, 1945.

The complaint alleges the wholesale rates charged by the Kentucky company for the sale of natural gas to the Pittsburgh company and by the Pittsburgh company to Equitable Gas Co., which distributes at retail in the Pittsburgh area are unjust and unreasonable.

Natural Gasoline

Phillips Sells Seaboard Philgas Properties

BARTLESVILLE, Okla.—Phillips Petroleum Co. has entered into a contract for the sale of its retail Philgas properties on the eastern seaboard to Suburban Propane Gas Corp., a newly formed organization, for $11,000,000. The properties involved are in eight Atlantic Coast states and the District of Columbia. Under a purchase agreement Phillips is to supply the new company with all its gas requirements for 20 years. In addition, Phillips will give advisory service and has granted the right to the use of certain patents, including those on its self-service system.

The sale is conditional on the financing of the property purchase by the new company, which has filed a registration statement with Securities and Exchange Commission. Phillips will continue its industrial and wholesale marketing of liquefied gas in the East and will become even more active in the Mississippi Valley and Great Lakes areas.

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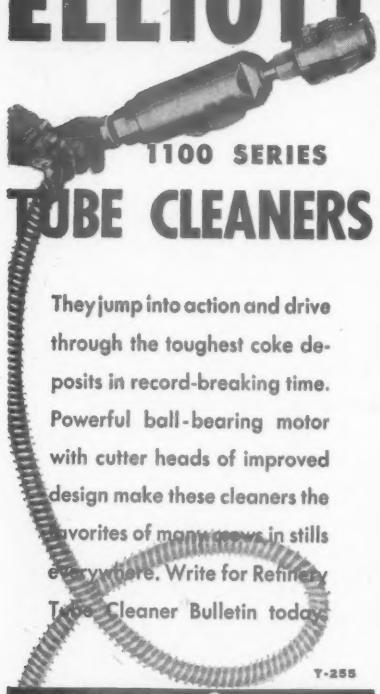

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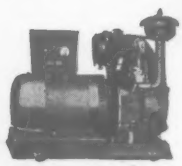

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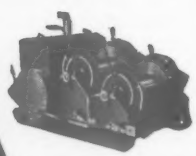

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REFINING

Leonard Refineries to Get Thermofor Cracking Unit

WILMINGTON, Del.—Under contracts executed by Houdry Process Corp., Wilmington, and Leonard Refineries, Inc., Alma, Mich., Leonard will acquire a Thermofor catalytic cracking unit, the first small-scale unit to be built with private capital to operate for postwar gasoline production.

The unit has been designed by Houdry engineers to process 3,000 bbl. of charge stock daily. Though it embodies simplifications in design, it is similar in principle to the larger Thermofor units built for the war program. The simplifications include integral elevator design for both spent and regenerated catalyst. Increased catalyst rates make possible the elimination of vapor superheaters. The over-all height has been reduced.

Contract Let for Buildings At Bruceton Laboratory

WASHINGTON.—A $995,000 contract has been awarded to Navarro Corp., of Pittsburgh, by the Department of the Interior for construction work to complete the major buildings of the new Bureau of Mines synthetic liquid fuels research and development laboratory near Bruceton, Pa. Four bids, ranging from $891,700 to $1,065,000, were submitted. The laboratory project is designed to improve processes for producing oil and gasoline from coal and lignite.

When the proposals were opened it was found that the low bid had been submitted jointly by Helvenston Construction Co. of Pittsburgh, and Lakeport Service Co., Inc., of Camp Hill, Pa. These companies relinquished their claims and declined the contract, Secretary Harold L. Ickes stated, when it developed that they probably would be unable to complete the job within the time and cost limits named, owing chiefly to difficulties in obtaining brick and tile shipments and to changes in road construction and structural steel fabrication schedules. Navarro was the second lowest bidder. Work is to be completed within 350 days.

The laboratory at Bruceton will be operated in conjunction with a synthetic liquid fuel demonstration plant to be established near Louisiana, Mo. There the Bureau of Mines is taking over the Missouri Ordnance Works, a $17,500,000 wartime synthetic ammonia plant, which will be converted to a demonstration plant for the production of oil and gasoline from coal by the hydrogenation and gas-synthesis processes. Process improvements developed in the laboratory will be tested on a commercial scale in the demonstration plant, thus providing a blueprint for the development of a synthetic liquid fuels industry by private enterprise.

Skelly Installing Recovery Unit at Eldorado Plant

Skelly Oil Co. last week announced plans for installation of facilities at its Eldorado, Kans., refinery for recovery of light petroleum fractions. By further processing, these fractions, formerly used as refinery fuel, will be converted into liquid petroleum fractions, polymer gasoline, and motor gasoline.

Facilities covered in the program include vapor-recovery unit to process straightrun and cracked vapors from crude distillation, storage tanks, and pressure cracking stills, and to prepare feed stocks for polymerization treatment. Plans call for completion of the unit in April 1946.

The program also includes installation of high-pressure condensing equipment for No. 9 cracking at 11 (the heavy coil of its principal cracking unit) to process cracked gases at higher pressure, and so dovetail with high-pressure condensing equipment at other cracking stills and the vapor recovery system. Replacements and repairs of a still damaged in a recent fire are under way.

Changes are being made at the

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polymerization unit and straightrun distillation unit to permit their working in conjunction with the vapor-recovery unit.

New Cracking Unit Meets Needs of Small Refiner

CHICAGO.—Lower investment cost and marked reduction in operating and maintenance requirements are offered by a new simplified catalytic-cracking unit for small refiners perfected by Universal Oil Products Co. and designated as the MS type. These improvements are said to result in installation and operating costs comparable with those of a thermal cracking unit. Features of the new unit are reported to include:

1. Reactor and regenerator have been combined in a single vessel erected as a self-supporting column completely shop-fabricated.

2. The large regenerator riser has been eliminated; the regenerator riser is greatly shortened, with small piping generally eliminated and simplified.

3. All secondary catalyst recovery equipment has been eliminated.

4. Efficiency of reactor and regenerator has been improved by additional distribution grids in each section.

5. Air for combustion passes through regenerator countercurrent to catalyst, permitting multistage stripping and total utilization of oxygen.

The most simple design is based on use of a microspherical synthetic (MS) catalyst, but powdered catalyst, synthetic or natural, can be used with design additions. Two synthetic catalysts are available, silica-alumina for maximum octane rating and silica-magnesia for yield. Also natural catalyst may be used, giving octane and yield values intermediate to those of synthetic catalyst.

Refiners Raised Wages 22 Per Cent in 4 Years

WASHINGTON. — Petroleum refineries have boosted straight-time hourly wage rates a little more than 22 per cent since January 1941, a Bureau of Labor Statistics study reveals. The figure is still about 10 per cent short of the 33 per cent rise in cost of living estimated by the Government to have taken place between January 1941 and July 1945.

The BLS study, still incomplete, covers manufacturing industries and is aimed at determining which industries have not advanced basic wages in proportion to living cost increases.

The administration will use the BLS study as an index in studying cost-of-living wage increases. To some extent, it will also become a basis for price relief to industries who seek increases in ceiling prices to compensate for wage rises granted to compensate for cost-of-living increases during the war years.

BLS spokesmen say that industries are interested in the study as a yardstick for evaluating wage rates. The study, BLS believes, will be an accurate reflection of the trend, although obviously subject to some margin of error.

Upon completion of this study, BLS may initiate a similar study for oil drilling and mining if a satisfactory basis for computation can be developed. The formula used in the manufacturing study, which eliminates overtime payments, cannot be applied as precisely to drilling and mining.

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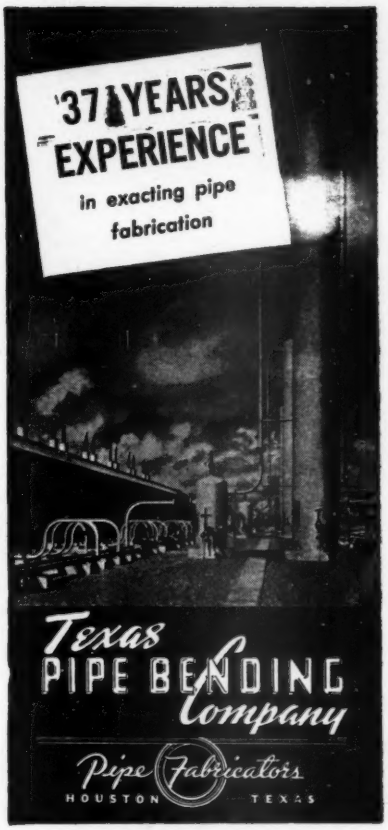

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PIPE LINES

El Paso Natural Prepares For Tex.-Calif. Gas Line

El Paso Natural Gas Co. is preparing to lay more than 700 miles of 26-in. for a pipe line from West Texas to California in the spring of 1946. Since the El Paso company has been accustomed to handling all construction work with its own organization, it is expected that much of the project will be handled by spreads employed directly by the company. However, there is a possibility that certain parts of the undertaking will be contracted. For this job it is believed that four spreads will be required.

After the Texas-California line has been completed to connect with facilities, to be built to the California-Arizona boundary by a subsidiary of Pacific Lighting Corp., the El Paso company is reported to be contemplating the laying of a 280-mile 24-in. line to extend from the 26-in. system at a point near Jal, N. M., to Dumas, Tex. This later project is expected to be started early in 1947.

The date of the hearing on the Texas-California project has not yet been set by the Federal Power Commission. A hearing on the subject by California state regulatory authorities has been scheduled for December 17 in Los Angeles.

Great Lakes Prepares For 300-Mile Project

Great Lakes Pipe Line Co. has issued specifications for laying approximately 300 miles of 8-in. consisting of approximately 200 miles between Kansas City and Omaha and 100 miles between El Dorado and Humboldt, Kans. Bids are to be submitted about January 1; construction is to begin in March 1946.

Interstate Shifts Operating Executives

Several important changes in the operating staff of Interstate Oil Pipe Line Co. have been announced by Bruce Ramsey, vice president in charge of the northern division's operations.

James M. Bradley has been named assistant manager of the northern division which comprises the company's operations in Oklahoma, Illinois, Kentucky, Montana, and Wyoming. George B. Randels, recently discharged from the Army, returns

PIPE-LINE PERSONALITIES

J. BOYD, partner and general manager, O. E. Dempsey Construction Co., was born at Caney, Kans., August 28, 1901. His father

was a minister in the Baptist Church and he resided at several places in Kansas and Missouri when Boyd was growing up. A knee injury led to Boyd's medical discharge from the Navy when he was a midshipman at Annapolis in the class of 1924.

After receiving his engineering degree from Carnegie Institute of Technology in 1926 he engaged in foundation work for 5 years. In 1930 he met Stanolind Pipe Line Co. officials when he was in charge of foundation construction for the Santa Fe high level railroad bridge at Chillicothe, Ill. At that time Stanolind was installing a river crossing at the same location. As a result of this contact he joined Stanolind as assistant chief engineer in May 1931 and continued in that position until he was promoted to general superintendent July 1, 1945. Within recent weeks he left the Stanolind organization to join the pipe line contracting organization of Oscar E. Dempsey.

Boyd is married and has two daughters; Ann age 15 and Joan 9.

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to the company as general superintendent of the northern division.

Francis Coryell, who came to Interstate from the pipe line department of Standard Oil Co. of Louisiana in 1943 with a background of experience with mechanical equipment, will thus be free to devote his time to the active research and development program which the company contemplates.

Bradley, first employed by the Oklahoma Pipe Line Co. in 1922, resigned in 1937 to go to Venezuela for Standard Oil Co. of Venezuela. He returned to the states in 1941 to join the operating staff of Plantation Pipe Line Co. as superintendent of the eastern division, managing operations from Atlanta, Ga., to Greensboro, N. C. He rejoined Interstate December 1.

Randels, who returned to Interstate November 28, was superintendent of the Oklahoma division before entering the service. Commissioned a major in 1943, he served some 2 years in the Army's 12th engineering district with headquarters in Calcutta, India, which had charge of the operation of pipe line, also barge and tank car loadings.

Stanolind Establishes Pilot Butte Tariff

DENVER, Colo.—Stanolind Pipe Line Co. has established a new tariff for transportation of crude from Pilot Butte, Wyo., to Wood River, Ill., of 37 cents, putting Wyoming black oil fields on a more competitive basis with West Texas crudes. This is important for Wyoming fields which underwent extensive black oil development during the war.

The first of two 500-hp. pump units manufactured by Cooper-Bessemer Corp. arrived early this week at Stanolind Pipe Line Co.'s station at Rangely, Colo., and is now being installed. It is expected that it will be in operation about January 1. The unit represents a departure from previous design. Both the 10-cylinder pump and the 6-cylinder engine have been made by Cooper-Bessemer so that they will operate at the same speed of approximately 400 r.p.m. A second unit of the same type and size is scheduled to arrive at the Rangely station later this month.

Interstate Starts Mattoon, Ill., Line

Interstate Oil Pipe Line Co. has begun construction of a 19-mile 8-in. line from its Montrose pump station to the Ohio Oil Co. system near Mattoon, Ill. The work has been contracted by Williams Brothers Corp., Tulsa.

The Williams Brothers organization has contracted with Mene Grande Oil Co. for the building of six 80,000-bbl. tanks manufactured by Chicago Bridge & Iron Co. at Oficina, Venezuela. Material arrived December 12 at Puerto la Cruz.

This contractor is also engaged in laying 10 miles of 3-in. for the Green County Gas Co., affiliated with United Carbon Co. near Greensburg, Ky.; 10 miles of 6-in. for Kentucky Natural Gas Co. near Henderson, Ky.; 10 miles of 8-in., 10-in., 12-in. and 16-in. for Atlanta Gas Co. at Atlanta, Ga.; and a river crossing at the Mississippi River near Fort Madison, Iowa, for Stanolind Pipe Line Co.

FPC Considers Pleas for New Gas-Line Facilities

Federal Power Commission hearing on applications of Natural Gas Pipeline Co. of America and its affiliate, Texoma Natural Gas Co., seeking authorization to expand natural-gas transportation facilities was held in Chicago December 10.

The companies are seeking permit to construct new facilities estimated to cost $18,000,000 for the purpose of increasing transmission capacity from the present rate of 268,000,000 cu. ft. daily to 349,000,000.

A group of western railroads was permitted to intervene in the proceedings.

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Exploration and Drilling

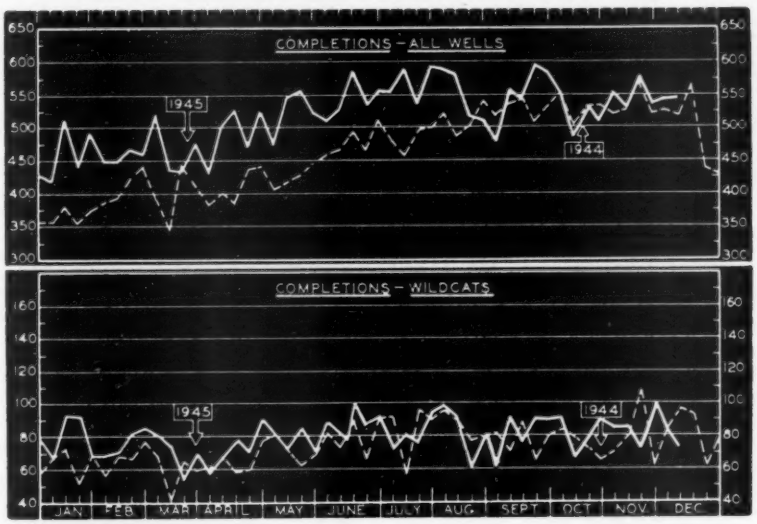
Week's Highlights

THE complex nature of the pre-Permian geology in West Texas is indicated again in striking results in and near the Fullerton field in Andrews County. Ellenburger production has apparently been found finally by Fullerton Oil Co. 322-A (formerly 9-A) Wilson, SE NW Section 16, Block A-32, PSL, on the west side of the Fullerton Permian field. This is approximately 2 miles east and 1 mile south of Magnolia Petroleum Co. 1-A Ralph, which was dry in the Ellenburger in Section 12, Block A-37, PSL.

On drill-stem test, the Fullerton test flowed mud in 18 minutes, oil in 35 minutes. After flowing 40 bbl. of fluid in the first hour, it died, and when testing tool was pulled, it was found plugged. The well will be acidized and retested.

Meanwhile, Mid-Continent Petroleum Corp. 3-11, NW NE 29, Block 13, University land, about 5 miles south and 1½ miles east of the indicated Ellenburger discovery, is passing up the regular Devonian pay in that area and nearing the top of the Ellenburger.

However, Mid-Continent has apparently opened up a new pool in the Devonian pay, south of the present Devonian, or 8,500-ft. pay area, which in turn is just south of the Permian production of the Fullerton field. Mid-Continent's new discovery is apparently separated from the 8,500-ft. pay area by a dry hole. The discovery, 1-15, NE NW Section 42, Block 13, University land, is 1½ miles southwest of Frank and George Frankel's well, NW NW Section 32, Block 13, University, which



Solid line charts current weekly completions—service wells included

WEEKLY WELL COMPLETIONS . . . WEEK ENDED DECEMBER 8, 1945

	Total of all wells					Cum. to date		Wildcat completions and discoveries					Cumulative total, 1945				
	Comp.	Oil	Gas	Dry	Footage	1945	1944	Oil	Dist	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	31	14	0	*17	45,977	1,388	1,503	0	0	0	0	0	0	0	0	0	0
Pennsylvania	71	34	5	†32	115,782	3,794	3,936	0	0	0	0	0	0	0	0	0	0
West Virginia	20	1	15	‡4	50,342	766	846	0	0	0	0	0	0	0	0	0	0
Ohio	33	12	10	11	87,366	943	960	0	0	0	3	3	0	0	14	61	75
Indiana	3	1	0	2	4,002	184	238	0	0	0	0	0	7	0	0	25	32
Kentucky	9	2	5	2	24,113	539	723	0	0	0	2	2	23	0	4	51	78
Illinois	35	23	0	12	89,340	1,705	1,852	0	0	0	4	4	51	0	0	297	348
Michigan	20	7	4	9	55,344	717	639	0	0	2	8	10	11	0	7	269	287
Kansas	44	24	5	‡15	149,948	1,663	1,738	0	0	0	5	5	35	0	15	322	372
Neb., Mo., Iowa	1	0	0	1	2,538	29	39	0	0	0	0	0	0	0	0	18	18
Oklahoma	54	29	3	22	188,926	2,269	1,742	1	0	0	11	12	77	3	18	339	437
Texas	141	86	15	40	640,299	6,747	5,357	5	1	1	20	27	198	16	54	1,205	1,473
North Central	52	26	1	‡25	139,826	2,074	1,413	1	0	0	8	9	71	0	5	427	503
West	24	19	0	5	120,147	1,636	1,504	1	0	0	3	4	53	1	0	238	292
Panhandle	7	4	3	0	21,883	511	285	0	0	0	0	0	0	0	1	7	8
Eastern	13	6	5	2	83,474	363	306	0	0	0	2	2	6	8	2	84	98
Gulf Coast	39	26	6	7	247,484	1,580	1,208	3	1	1	6	11	54	6	35	277	372
Southwest	6	5	0	1	27,485	483	641	0	0	0	1	1	14	1	11	172	198
Louisiana	31	22	3	6	210,634	1,032	770	0	0	0	1	1	32	4	6	116	158
Northern	12	10	0	2	35,888	446	307	0	0	0	0	0	8	1	6	68	83
Southern	19	12	3	4	174,746	586	463	0	0	0	1	1	24	3	0	48	75
Arkansas	1	0	0	1	1,303	167	199	0	0	0	0	0	2	0	0	35	37
Mississippi	6	4	0	2	41,903	345	151	0	0	0	1	1	6	0	0	114	120
Southeastern States	1	0	0	1	3,040	57	50	0	0	0	0	0	1	0	1	37	39
Montana	6	4	2	0	14,080	299	331	0	0	0	0	0	10	0	0	24	34
Wyoming	4	4	0	0	14,506	214	169	0	0	0	0	0	18	0	1	44	63
Colorado	1	1	0	0	6,455	52	33	0	0	0	0	0	1	0	1	11	13
Utah	1	0	1	0	3,246	1	0	0	0	1	0	1	0	0	1	0	1
New Mexico	5	2	0	3	23,514	390	378	1	0	0	2	3	11	0	6	61	78
California	30	22	0	8	129,510	2,089	1,884	0	0	0	3	3	4	0	2	218	224
Total United States	548	292	68	188	1,902,168	25,390	23,538	7	1	4	60	72	487	23	130	3,247	3,887
Total previous week	542	282	55	205	1,771,363	24,842	23,057	7	0	2	72	81	480	22	126	3,187	3,815
Total Dec. 9, 1944	549	301	44	204	1,789,337	23,538	16,944	10	0	2	85	97	430	26	117	3,074	3,647

Service wells included: *14, †31, ‡1.

missed the Devonian and was abandoned at 8,777 ft. without testing the lower formations.

The newest Devonian discovery of Mid-Continent is 1½ miles west and 1 mile north of Stanolind Oil & Gas Co. 1-P, a Devonian producer that looks as though it should be in a different pool from either Mid-Continent's latest discovery, or the Fullerton 8,500-ft. pool, some 2½ miles due north of the 1-P. Reported data indicate the regular Fullerton 8,500-ft. Denvonian produces from datum levels of about —5,100 ft., the Stanolind 1-P from —5,400 ft., and the Mid-Continent's newest discovery is reported at about —4,800 ft. The Mid-Continent test flowed 100 bbl. per hour on drill-stem test.

SOUTH LOUISIANA

New Pay Discovered in Napoleonville Area

NEW ORLEANS.—A new oil sand has been discovered by a deep test on the old Napoleonville Dome, in Assumption Parish. Shell Oil Co., Inc. 1 C. L. Triche, 33-12s-13e, encountered new oil sand at 9,430-78 ft., and a production test is now being made through perforations at 9,462-78 ft. Total depth is 9,763 ft. in shale with 5½-in. casing set on bottom.

Barnsdall Oil Corp.-Vincent & Welch et al 1 Homeseekers Development Co., a wildcat test in the West Tepetate area of Acadia Parish, 10-7s-2w, has been abandoned after running an electrical log to total depth of 9,450 ft. No commercial shows were indicated.

There were 10 new locations reported this week 3 of which are wildcats, 2 in Jefferson Parish and 1 in Orleans Parish. Nineteen completions, 12 oil, 3 gas and 4 dry, were reported this week. Only one test was a wildcat in Acadia Parish, and it was dry. Acadia led with five completions, Terrebonne Parish was next with four.

WILDCAT FAILURES IN SOUTH LOUISIANA

Acadia Parish: Barnsdall-Vincent & Welch et al 1 Homeseekers Development Co., 19-7s-2w, in West Tepetate area, dry at 9,450 ft.

EASTERN TEXAS

Hopkins Wildcat Shows Gas-Cut Mud on Test

DALLAS.—Delta Drilling Co. 1 Livingston, Nacogdoches University Survey, southern Hopkins County wildcat, 3 miles southeast of Reilly Springs, ran a drill-stem test from 7,740-93 ft. and recovered a small amount of gas-cut mud. Operator was drilling ahead at 8,090 ft.

Humble Oil & Refining Co. 1 Lutz, Allison Survey, wildcat 3 miles west of Jackson, Van Zandt County, was drilling below 6,364 ft. with no shows after drill-stem test at 6,105 ft. showed water.

Sohio Petroleum Co. 1 Butler, Gideon Survey, Rains County wildcat, 7 miles northeast of Emory, on a 2-hour drill-stem test from 7,648-73 ft. recovered 900 ft. of mud and 2,000-ft. water blanket with no shows. It was drilling below 7,700 ft.

Delta will drill a Travis Peak wildcat 3 miles south of Henderson in Rusk County. It is 1 C. C. Rayford, 7,000 ft. from the west line and 5,200 ft. from the south line of the James Smith Survey.

The Carthage field, Panola County, has five completions and Pickton field, Hopkins County, and Hawkins field, Wood County, each had two. The Hawkins field reported eight new locations.

WILDCAT FAILURES COMPLETED IN EAST TEXAS

Leon County: E. H. Robertson 1 Wilson & Reding, E. Chandler Sur., at town of Cairo, elev. 252 ft., Austin 7,434 ft., Sub-Clarksville 7,806 ft., dry, TD 8,406 ft.

Claude Bell 1 C. C. Cole, Thos. H. Garner Sur., 3½ mi. SE Flynn, elev. 427 ft., dry, TD 1,004 ft.

TEXAS GULF COAST

North Winnie Well Proves Productive in New Pay

HOUSTON.—A new sand for the North Winnie area has been opened by Sun Oil Co. 1 Hankamer, in the F. Valmore Survey, Chambers County. Drilled to a depth of 10,549 ft., the well flowed at the rate of 393 bbl. of 42-gravity oil daily through a 12/64-in. choke from 20 perforations at 8,713-18 ft. Tubing pressure was 2,050 lb., and casing pressure 700 lb. Gas-oil ratio was 1,518 to 1. The 7-in. casing was set at 8,801 ft.

A new oil pool, 4 miles northwest of Willis, in Montgomery County, has been opened by K. B. Knox Drilling Co. 1 J. W. Wood, Wm. Weir Survey 42. This well was drilled to a total depth of 3,762 ft., and on potential test flowed an estimated 12 bbl. of 27-gravity oil through a ¼-in. choke. Shut-in tubing pressure is 174 lb., and casing pressure 465 lb. Top of sand is 3,755 ft. with perforations at 3,761-62 ft.

Union Oil Co. of California 3 E. Hawes and Lizzie M. R. Hawes estate, John Huff League, Abstract 31, Boling field, Wharton County, opened a new oil sand topped at 4,883 ft. Total depth is 5,256 ft. with perforations at 4,882 to 4,990 ft. This well flowed 14 bbl. per day through a ⅛-in. choke, with no pressure, on potential test and is now shut in.

Sun Oil Co. has abandoned exploration in the old Humble field, Harris County. Sun 41 Bender estate, in the W. B. Adams Survey, drilled out of rock just below 3,380 ft., and was bottomed in salt at 3,414 ft. Electric log was run before the hole was plugged.

Humble Oil & Refining Co. 1 Mrs. R. Greenebaum et al, a wildcat in the West El Campo area of Wharton County, Section 57, ETRR Survey, Abstract 122, was dry at 6,900 ft. in shale.

Twenty-six new locations were reported this week, 10 being wildcats, 2 in Colorado County, 4 in Harris, and 1 each in Fort Bend, Jackson, Jefferson, and Lavaca counties. There were 17 completions, with 2 successful wildcats, 1 new oil pool discovery in Montgomery County, and 1 new-pay strike in Wharton County, and 3 dry holes, 1 each in Chambers, Jackson, and Wharton counties. Wharton County led with three completions reported.

SUCCESSFUL WILDCATS IN UPPER GULF COAST

Montgomery County: New oil pool—K. B. Knox Drilling Co. 1 J. W. Wood, Wm. Weir Sur. 42, 4 mi. NW of Willis, TD 3,762 ft., perf. 3,761-62 ft., top sand 3,755 ft., PT: flowed estimated 12 bbl. daily through a ⅛-in. choke. Shut-in TP 174 lb., CP 465 lb., gravity 27°, no water.

Wharton County: New oil sand, Boling field—Union Oil Co. of California 3 E. Hawes and Lizzie M. R. Hawes, John Huff Lg., Abst. 31, top sand 4,883 ft., TD 5,256 ft., perf. 4,882 to 4,900 ft., PT: flowed 14 bbl. per day through a ⅛-in. choke, no pressure.

WILDCAT FAILURES IN UPPER GULF COAST

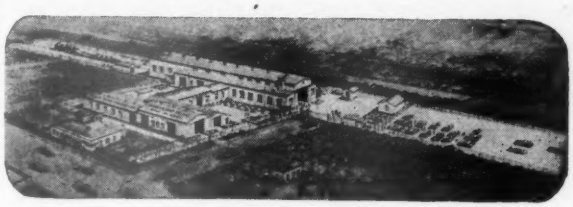
Chambers County: Sterling Oil & Refining Corp. 1 J. E. Eula Cline, J. Whitcomb Lg., Abst. 27, Blk. 2-A, 15 mi. SE of Anahuac, dry at 9,063 ft.

Jackson County: Stewarts et al 1 Robt. Claybrook, Ramon Musquez Sur., 2

DAILY AVERAGE PRODUCTION FOR WEEK

	Dec. 8 crude oil	Bureau of Mines demand forecast	State allowable	Dec. 1 crude oil
Alabama	700	400	.....	700
Arkansas	76,000	83,273	78,397	76,000
California	837,250	850,000	.....	840,500
Colorado	19,050	20,000	.....	14,400
Eastern	63,400	65,200	.....	58,300
Florida	100	100	.....	100
Illinois	204,800	213,000	.....	202,700
Indiana	12,500	13,500	.....	13,200
Kansas	242,150	268,000	255,000	241,500
Kentucky	29,950	29,000	.....	28,900
Louisiana	370,800	365,000	406,135	369,250
North Louisiana	75,500	.....	.....	75,600
South Louisiana	295,300	.....	.....	293,650
Michigan	43,100	47,000	.....	43,800
Mississippi	74,850	48,000	.....	52,250
Montana	22,950	22,000	.....	22,650
Nebraska	750	800	.....	750
New Mexico	102,000	102,000	104,000	101,700
Oklahoma	388,000	388,000	388,000	385,800
Texas	1,918,900	1,940,000	1,938,369	1,894,700
East Texas	307,000	.....	.....	316,500
East Central Texas	130,300	.....	.....	128,000
North Central Texas	149,650	.....	.....	147,100
Texas Panhandle	81,000	.....	.....	81,000
West Texas	465,800	.....	.....	457,750
Southwest Texas	314,550	.....	.....	300,100
Texas Gulf Coast	470,600	.....	.....	464,250
Wyoming	85,850	92,000	.....	92,400
Total United States	4,493,100	4,542,000	.....	4,439,600
Change from previous week	up 53,500			

Total production January 1-December 8, 1945 ..... 1,601,077,325 bbl.
Same period last year ..... 1,564,470,700 bbl.



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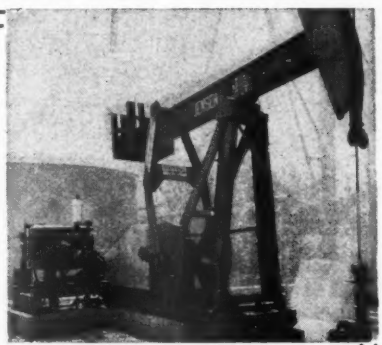

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mi. NW of Vanderbilt, dry at 4,900 ft.

Wharton County: Humble Oil & Refining Co. 1 Mrs. R. Greenebaum et al, Sec. 57, ETRR Sur., Abst. 122, West El Campo area, dry at 6,900 ft.

SOUTHWEST TEXAS

Gas-Condensate Pool Opened Near Goliad

CORPUS CHRISTI.—Approximately 12 miles southwest of Goliad, Goliad County, a new gas-condensate pool has been opened by Magnolia Petroleum Co. at 1 R. F. Irby. Drilled to a total depth of 11,726 ft., with plugged-back depth at 9,920 ft., this well flowed 83 bbl. of condensate on a 15-hour test through 11/64-in. choke, with 6,090 lb. working pressure, 6,885 lb. shut-in pressure, gas-oil ratio 48,100 to 1. The open-flow gas production was estimated at 21,000,000 cu. ft. per day. Production is through perforations in the Wilcox at 9,884-95 ft. The 7-in. casing was set to 10,588 ft. Tests run at the 10,000-ft. level showed gas and salt water. A test in perforations at 9,900-10 ft. showed some gas-condensate.

A new gas pool has been opened by H. J. Porter 1 D. L. Miller, in J. S. Hendershot Survey, 5½ miles east of Telferner, Victoria County. The well was drilled to total depth of 4,444 ft., and gaged 15,000,000 cu. ft. of gas per day on open flow. Production is from open hole at 4,438-44 ft.

The Harrus Syndicate (formerly W. H. Holland) 1 M. M. Garcia, discovery well in the Parsons area, Starr County, flowed a Railroad Commission potential of 123 bbl. daily through a ½-in. choke, gas-oil ratio 276 to 1, tubing pressure 380 lb., casing pressure 1,020 lb., gravity estimated 41°, no water. Total depth is 4,520 ft., with 5½-in. casing set to 3,614 ft. and production is from perforations in the lower Frio zone at 3,498 to 3,512 ft.

A new gas-condensate pool is indicated by Mills Bennett 1 Martha Berger et al, a wildcat in Section 19, Ragley Subdivision, J. M. Uranga Grant, 2 miles southwest of Tuleta in Bee County. On a drillstem test in Wilcox at 7,896 to 7,905 ft., open 3½ minutes, operator recovered 20 ft. of condensate against 640 lb. working pressure. Operator drilled to 8,001 ft., and ran an electric log. A string of 7-in. casing has been set to 8,000 ft. Bennett plans to drill deeper, possibly to top of the Massive before trying for completion.

Blanco Oil Co. and Al Buchanan 1 A. M. Bruni estate, new oil pool opener in Webb County, 8 miles southwest of Bruni, is completing on the pump and is reported making 100 to 150 bbl. per day. Total depth is 2,317 ft., with 5½-in. casing set to 2,313 ft. with completion in open hole. Location for 2 Bruni has been spotted 660 ft. east and 660 ft. north of the discovery producer.

Humble Oil & Refining Co. 2-C D. J. Sullivan opened a new oil sand at Mariposa field in Brooks County. The well was drilled to 9,105 ft. in oil sand and flowed at the rate of 10 bbl. per hour through a ⅛-in. choke, with tubing pressure of 2,700 lb. Operators are still testing.

There were 37 locations reported this week, 14 being wildcats with 2 each in De Witt, Kleberg, and Starr counties, and 1 each in Calhoun, Duval, Gonzales, Jim Hogg, Jim Wells, Nueces, San Patricio and Zapata counties. Of the 28 completions, 7 were wildcats, 3 successful being 1 new condensate pool in Goliad County, 1 new gas-condensate pay in Refugio, and 1 new gas pool in Victoria County, and 4 dry holes, 1 each in Live Oak, Nueces, Refugio and Webb counties. Nueces, Jim Wells and Refugio counties shared the lead with three completions each.

SUCCESSFUL WILDCATS IN SOUTHWEST TEXAS

Goliad County: New condensate pool—Magnolia Petroleum Co. 1 R. F. Irby, Jos. Callahan Sur., 12 mi. SW of Goliad, TD 11,726 ft., PB TD 9,920 ft., perf. 9,900-10 ft., PT 134 bbl. condensate 24 hours through 11/64-in. choke, gas-oil ratio 48,100 to 1, no water.

Refugio County: New gas condensate pay, North LaRosa field—Phillips Petroleum Co. 1 S. Bill, Sec. 40, Johnson & Pugh. Subd., TD 9,203 ft., perf. 6,156-72, PT 46 bbl. condensate 24 hours through 3/16-in. choke, gas-oil ratio 29,700 to 1, open flow 24,600,000 cu. ft. gas per day, TP 2,100 lb., gravity 60°, no water.

Victoria County: New gas pool—H. J. Porter 1 D. L. Miller, J. S. Hendershot Sur., Abst. 183, 5½ mi. E of Telferner, TD 4,444 ft., producing from open hole 4,438-44 ft., PT 15,000,000 cu. ft. gas per day open flow, shut-in TP 1,100 lb., CP 1,300 lb.

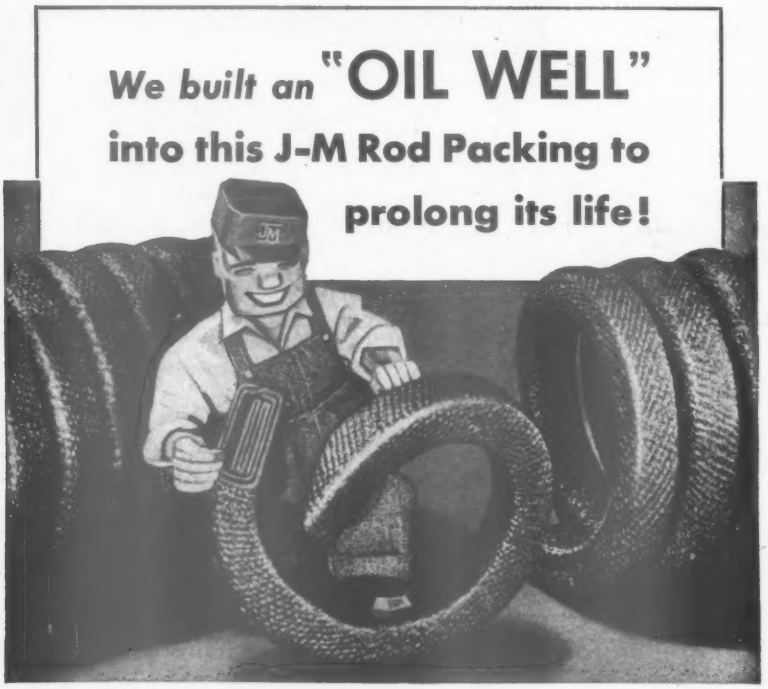
WILDCAT FAILURES IN SOUTHWEST TEXAS

Live Oak County: Joe Stelzig 1 Joe Stelzig, 1 mi. N of Kittie, on Geo. W. West estate, Sec. 1, dry at 2,194 ft.

Nueces County: Homer Easterwood et al 2 Mantor-Briggs, Manto-Briggs & Kuykendall Subd., Blk. 9, 3 mi. NW of Banquette, dry at 6,850 ft.

Refugio County: Blanco Oil Co. and Al Buchanan 1 John J. Power et al, Jose Manuel Blanco and Power & Hewitson Sur., 10 mi. N of Refugio, 2 mi. SW of Gaffney field, dry at 5,820 ft.

Webb County: Humble Oil & Refg. Co. 2 Mary Kate Withers, Jesus Jaurez Sur. 1412, 18 mi. E of Encinal, dry at 7,375 ft.



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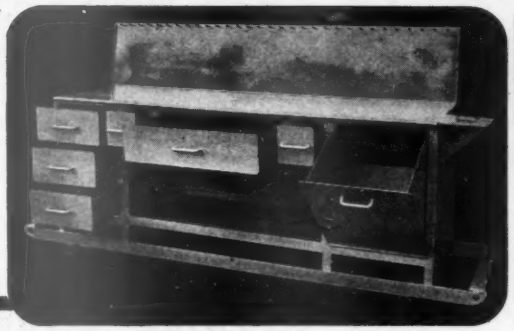

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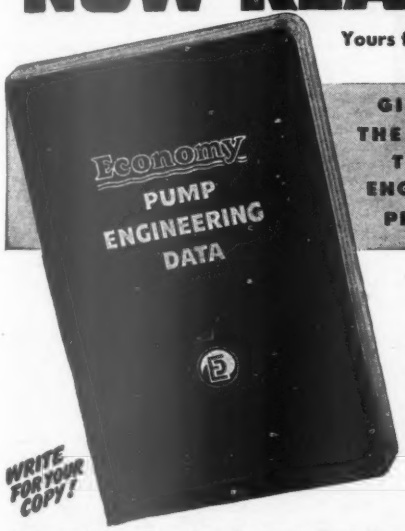

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MICHIGAN

Two Gas Wells Reward Michigan Wildcatters

SAGINAW.—Michigan wildcatting developed two new gas wells last week, in Newayco and Oceola counties, as operations resulted in 20 completions for seven oil wells, 4 gas wells, 9 dry holes. Seven new locations were announced.

New oil wells includes two more gushers in the Deep River field of Arenac County. The new locations are in Arenac, Bay, Midland, Mecosta, Missaukee, Ottawa and Van Buren counties.

MICHIGAN WILDCAT FAILURES

Allegan County, Overisel Township: H. C. Nelson 1 A. B. Sneller, NE SE NW 5-4n-14w, dry in Traverse limestone, TD 1,508 ft.

Crawford County, Grayling Township: George G. Hanners, Tr., 1 Timerland, Inc., NE NE SE 16-26n-2w, dry, TD 4,317 ft.

Mecosta County, Morton Township: Chapman Oil Co. 1 V. Minkel, C S½ SW SW 7-14n-8w, dry in Dundee, TD 3,745 ft.

Austin Township: Michigan Consolidated Gas Co. 1 Burden, C SW Sec. 35, dry, TD 1,344 ft.

Montcalm County, Richland Township: Allegan Pipe & Supply Co. 1 Charles A. Williams, NW NW NW 36-12n-5w. dry in Dundee, TD 3,438 ft.

Sidney Township: Rex Oil & Gas Co. 1 E. E. Jensen, SE NE SE 18-10n-7w, dry in Dundee, TD 3,386 ft.

Montmorency County, Avery Township: McClanahan Oil Co.-Talbot Oil Co. 1 Kneeland-Bigelow, NE NE SE 16-30n-3e, dry in Dundee, TD 2,410 ft.

Van Buren County, Arlington Township: Del Fortney 1 E. A. and H. M. Roberts, SW NE SE 1-2s-15w, dry in Traverse limestone, TD 1,186 ft.

SUCCESSFUL MICHIGAN WILDCATS

Newago County, Goodwell Township: Taggart Brothers Gas Co. 1 Elmer Helems, SW SW SW 24-14n-11w, 613,000,000 cu. ft., TD 1,201 ft.

Osceola County, Orient Township: Sohio Petroleum Co. 1 Gas Unit, SE NW SE 13-17n-7w. 1,940,000 cu. ft., TD 1,516 ft.

FOR THE BEST IN CABLE TOOLS

Fig. F476 Fig. F481

For the Close Hole Job
SPANG
SOLID BORED FRICTION SOCKET
(Fig. F 476)
and MULTI-SLIP COLLAR SOCKET
(Fig. F 481)

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N. CENTRAL TEXAS

Sivalls Bend Outpost Indicates Extension

WICHITA FALLS.—Continental Oil Co. 1 Cox, Lot 32, Block 1, Henderson County School Lands, wildcat 1 mile north of Gibtown, southeastern Jack County, is dry at 6,255 ft. A 45-minute drill-stem test of the Ellenburger from 6,200-55 ft., recovered 160 ft. of salty mud with no oil, gas or bottom-hole pressure.

Mid-Continent Petroleum Corp. 1 Morris-S. Gann Survey, 1 mile northeast outpost to the Sivalls Bend pool of northern Cooke County, ran a 38-minute drill-stem test from 6,813-41 ft. It showed gas in 20 minutes and recovered 1,420 ft. of oil and 167 ft. of mud. It is shut down for orders.

Standard Oil Co. of Texas 2 Beasley, J. McKerley Survey, Sivalls Bend pool, on a 15-minute drill-stem test from 6,643-61 ft. recovered 3,360 ft. of oil, 168 ft. of oil-cut mud and 60 ft. of salty drilling mud. Operator was drilling below 6,720 ft. in sandy shale.

National Associated Petroleum Co. 1 Alexander, A. Buffington Survey, a wildcat 2 miles south of Nocona in northern Montague County, which has shown for production from the Caddo, drilled conglomerate with slight show of oil from 6,136-48 ft. in the Bend section. On a 48-minute drill-stem test of the section, recovery was 200 ft. of drilling fluid and salt water with no oil, gas or water but with bottom-hole pressure of 2,400 lb. It was being drilled below 6,189 ft.

Continental Oil Co. 1-C Heard, Block 3222, TE&L Survey, wildcat 3 miles southwest of Buffalo Springs, southern Clay County, drilled lime showing oil from 6,474-93 ft. Electric log was run at 6,493 ft., total depth, and 7-in. casing is being run.

Electra field, Wichita County, had six completions this week and Wilson field, Cooke County, had five. Wichita County reported 27 new field locations and Archer County 13.

WILDCAT FAILURES COMPLETED IN NORTH CENTRAL TEXAS

Archer County: Benson Bros. 1 Lloyd Turberville, Sec. 49, J. W. Harris Subd., 8 mi. W Archer City, elev. 1,039 ft., dry, TD 1,442 ft.

Bridwell 1-F Oil Investment Co., Blk. 125, John Harris Subd., 4 mi. NW Archer City, elev. 979 ft., Caddo 4,855 ft., dry, TD 4,925 ft.

Clay County: Wesley W. West and Norando Oil Co. 1 R. A. Brown, Sec. 70, HT&B Sur. A-965, 6½ mi. W and 1 mi. N Henrietta, elev. 988 ft., Caddo 5,690 ft., Ellenburger 5,950 ft., dry, TD 6,414 ft.

Cooke County: S. W. Petrie 1 J. W. Raiser, M. Trevino Sur. A-1021, 3 mi. N and 2½ mi. E Valley View, dry, TD 1,802 ft.

King County: Roy Lebus et al 1 W. R. Ross, Sec. 89, Blk. A, Jno. B. Rector Sur., 3 mi. S and 15 mi. E Guthrie, elev. 1,804 ft., Bateman 5,375 ft., dry, TD 5,505 ft.

Ohio Oil Co. 1 Pitchfork Land & Cattle Co., Sec. 1, Somerville CSL Sur., 10 mi. NW Guthrie, elev. 1,945 ft., Mississippian 6,465 ft., dry, TD 6,975 ft.
Throckmorton County: Panhandle Refining Co 1 Johnson, Sec. 2194, TE&L Sur., 3½ mi. W and ½ mi. S Elbert, elev. 1,237 ft., Ellenburger 5.124 ft., dry, TD 5,195 ft.

WEST CENTRAL TEXAS

ABILENE.—Sohio Petroleum Co. 1 Irl Faver, Section 50, Block 21, T&P Survey, Nolan County wildcat, 4 miles southeast of Sweetwater, on the first pull of the swab after perforating from 5,672-77 ft., recovered 1½ bbl. of oil. The second pull recovered muddy water. At the end of 1 hour it was reported to be making 100 per cent salt water. Alder Oil Co. will drill a 3,100-ft. wildcat 4 miles southwest of Merkel in Taylor County. It is 1,130 ft. from the west line and 450 ft. from the north line of Block 5, Burr and Caswell Survey.

The Regular field, Jones County, and Reddin field, Taylor County, each had two completions this week. The Reddin field reported three new locations.

SUCCESSFUL WILDCAT COMPLETION FOR WEST CENTRAL TEXAS

Jones County: New oil pool—Eastland Oil 1 W. L. Chittenden, Sec. 19, Leag. 335, Louis Kratz Sur., 8 mi. NW Anson, pumped 69 bbl. day through 2-in. tubing, perf. 3,018-25 ft., King, gravity 40, TD 3,036 ft.

WILDCAT FAILURE COMPLETED IN WEST CENTRAL TEXAS

Jones County: M. M. Travis 2 A. M. Heranius, Sec. 164, BBB&C Sur., 7 mi. N. Lueders, elev. 1,562 ft., Strawn 3,277 ft., dry, TD 4,585 ft.

CALIFORNIA

General Deepening New Well, Seeking More Gas

LOS ANGELES.—General Petroleum Corp. after producing its La Mirada wildcat for several days, decided to drill deeper in the hopes of finding sufficient gas to increase production. General's well, 1 Librown, 21-3s-11w, kicked off when first tested in November but failed to hold up and this together with a rather high water cut prevented completion. It is bottomed at 12,200 ft. and has 7-in. casing cemented at 12,042 ft. The bit was still in oil sand when drilling operations were stopped.

Richfield Oil Corp. was engaged in remedial work on 1 Union Pacific Unit in the Bandini district of Los Angeles Basin to correct water intrusion which has delayed completion. On a water shutoff test, this wildcat flowed at a daily rate of 750 bbl. of 32-gravity oil cutting 40 per cent water. The outlook is promising even though water may be coming from the formation as a higher structural location might be water-free. Top of the Miocene was placed in this wildcat at 7,450 ft., which indicates Richfield has penetrated the Miocene 1,158 ft. at the bottom of the hole, 8,608 ft. No test was made of an oil sand at 8,390 to 8,510 ft., as 8⅝-in. casing was subsequently landed at 8,561 ft.

Standard Oil Co. of California is drilling ahead in 1 Lewis Community in the Leffingwell district between Santa Fe Springs and West Coyote and Ohio Oil Co. continues work on its Gardena wildcat which showed promise of opening up a new field before water trouble developed. It is generally conceded, however, that Ohio has probably found a new pool at Gardena.

Independent Exploration Co. found the lower zone barren in its 1 Cymric, 21-29s-21e, at Cymric and has plugged back

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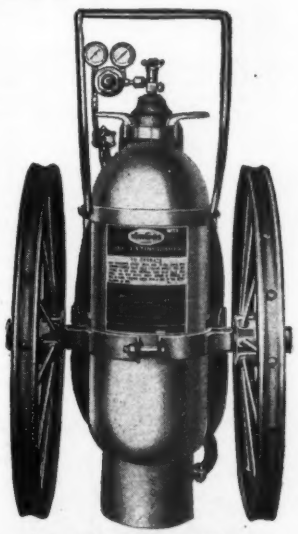

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to 2,864 ft. With the completion of this well a new zone has been proven productive at 2,810-64 ft.

New operations rose sharply this week due primarily to the staking of 10 locations by Macoil Co. in the Newport field. These wells will be spread out over the next several weeks.

CALIFORNIA WILDCAT FAILURES

Kern County, Buttonwillow: Transcal Drilling Co. 1 Buttonwillow, 30-28s-23e, bottomed in hard shale, no showings in gas sand, TD 5,020 ft.

Round Mountain: Miller, York & Claire 1 K.C.L., 13-28s-28e, bottomed in barren gray sand, cored 6 ft. of oil-stained sand in Vedder zone of Miocene age, not commercial, TD 2,398 ft.

Los Angeles County, Del Valle: Federal Oil Co. 1 Towle, 3-4n-17w, tested wet, swabbed small amount of heavy oil, not commercial, TD 5,011 ft.

APPALACHIAN FIELD

New Gordon Sand Pool Getting Good Producer

PITTSBURGH.—In North Strabane Township, Washington County, southwest Pennsylvania, Ed Beedle et al are completing another well in the new Gordon sand oil pool which filled up 2,200 ft. in the 8-in. hole and showing for a good producer. The Gordon sand was topped at 2,510 ft. with oil at 2,542-50 ft. It is located about 660 ft. south of the initial well on the Ackroyd farm.

In Indiana County, T. W. Phillips Gas & Oil Co. completed another good well in Washington Township gaging 1,917,000 cu. ft. gas from the Tiona sand. First gas was 9 ft. in the sand at 3,054 ft. and extended to 3,061 ft. with total depth 3,078 ft.

In Bell Township, Westmoreland County, Peoples Natural Gas Co. completed a test on M. J. S. Rugh farm with a final open flow of 2,348,000 cu. ft. gas from the Thirty Foot sand topped at 2,038 ft. and the gas at 2,075 ft. It rocked up to 810 lb.

Only one new location was made during the week and it was located in Porter Township, Clarion County.

In West Virginia, there was another good Berea gas well in Baileysville district, Wyoming County, where Godfrey L. Cabot, Inc. completed 1,164 John Gilbert with a gage of 2,214,000 cu. ft. gas after shot. There was a stray sand at 2,240 ft. with 103,000 cu. ft. gas from 2,282-85 ft. and 2,290-93 ft.

In Jackson County, United Carbon Co. topped the Corniferous lime in the test 1,320 W. E. Hupp in Ravenswood district, at 4,679 ft. and will run casing in that formation before drilling into the Oriskany.

During the week 11 new locations were announced. These were located in Laurel district, Lincoln County; Jefferson district, Nicholas County; Curry and Union districts, Putnam County; Slab Fork district, Raleigh County; Grant district, Ritchie County; Geary district, Roane County; Newark district, Wirt County, and Baileysville district, Wyoming County

ILLINOIS

Clay County Wildcat May Open New Field

MATTOON.—No new fields were opened in Illinois during the past week although Clay County had prospects of a new pool in the W. W. Shaffer 1 Wood 21-5n-6e, about 4 miles northeast of Iola. Operators have set 5½-in. casing on the McClosky at 2,797-2,803 ft., total depth 2,804 ft. Previously, on a 1-hour drill-stem test at 2,789-2,804 ft., 250 ft. of oil, 90 ft. of oil-cut mud and no water were recovered. The 1 Wood is about 5 miles from other oil production.

Four new oil pools, six extensions to pools, and one new pay horizon were discovered in Illinois during November according to the Illinois State Geological Survey. The new pools are Sumpter, a Tar Springs pool in White County; Markham City West, an Aux Vases sand pool in Jefferson County; Newton North, Jasper County, in the McClosky lime, and Goldengate North, Wayne County, producing from the McClosky and Rosiclare limes. Three extensions were completed to the Mattoon pool in Coles County, and one each to Clay City Consolidated in Wayne County, Marine in Madison County, and Bible Grove in Effingham County. The new pay is the McClosky lime in the Ingraham West pool of Clay County. The discovery well of this new pay horizon was also the biggest well completed during November, flowing 1,023 bbl. of oil daily on initial tests.

Daily average production for the state increased from 180,000 bbl. in October to 205,000 bbl. in November. Total estimated production during November was 6,144,000 bbl. as compared with 5,580,000 bbl. in October.

The most active fields in Illinois at the close of the month included Mattoon where more than 20 per cent of the drilling wells were located, Boyd, Calhoun, Brownsville, and Marine.

ILLINOIS WILDCAT FAILURES

Madison County: Obering 1 Landman, SW NE SW 21-5n-5w, dry at 2,140 ft., Ste. Genevieve 857 ft., Louisiana 1,791-1,811 ft., Devonian 1,880 ft.

Saline County: B. A. Baker 1 J. B. Hol-

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brook heirs, SW NW SE 13-9s-7e, dry at 2,612 ft., Palestine 1,612 ft., Menard 1,673 ft., Waltersburg sand 1,771 ft., Vienna 1,826 ft., Tar Springs sand 1,880 ft., Hardinsburg sand 2,010-14 ft., Cypress sand 2,264 ft., Benoist sand 2,385 ft., Aux Vases sand 2,516 ft.

National Assoc. Pet. 1 Phelps, NE NE SW 14-8s-5e, dry at 3,099 ft., McClosky 2,939-3,084 ft.

White County: Globe Refining Co. 1 Miller-Organ, NW SE NW 35-4s-9e, dry at 3,036 ft., Cypress sand 2,909 ft., Weiler 3,015 ft., Paint Creek 3,029 ft.

MISSISSIPPI

Eighty-Eighth Producer Completed in Eucutta

JACKSON.—Eucutta field of Wayne County is receiving its eighty-eighth producer and its best well to date in the completion of Sun Oil Co. 1 Board of Supervisor, 375 ft. north and 400 ft. east of SW corner of SE SW 2-9n-9w. Perforated at 5,164-83 ft. in the City Bank zone and at 5,247-73 ft. in the Stanley zone, the well is flowing 342 bbl. of 34.1-gravity oil per day through a 5/16-in. choke.

Completions for the week totaled six, four oilers, and two dry holes, one of which was a wildcat. The four new oil wells had a combined initial production of 1,085 bbl. per day. Three new locations have been announced for the state, one in Baxterville field of Lamar County, one in West Heidelberg field of Jasper County, and one a wildcat to be drilled in Jones County. Florida and Georgia each have one new wildcat location, the Florida test to be drilled in Bay County, and the Georgia test in Montgomery County.

MISSISSIPPI WILDCAT FAILURE

LeFlore County: S. J. Tucker et al 1 Pillow, NE NW 8-19n-1w, dry, TD 4,544 ft., Tuscaloosa 4,340 ft.

CANADIAN FIELDS

Record Nitro Shot to Be Tried at Turner Valley

CHATHAM, Ont.—In the Turner Valley field an attempt to release further oil production from near-depleted wells by shooting on an unprecedented scale is being made this month by Oil Well Reflow, Ltd., a company recently incorporated, largely by Winnipeg men, to handle the contemplated project.

The company has taken over a well fairly high in the oil zone near the south end of the field, in which production has declined to a few barrels. It is planned to shoot this well with 5,000 qt. of glycerin. K. C. Ball of Whittier, Calif., is in charge of operations, and under his supervision the explosive has been transported from Winnipeg to Calgary in trucks, escorted by men of the Royal Canadian Mounted Police to clear the route of traffic. The shot will be used primarily in the Madison limestone, the main producing formation, and though it is regarded as highly experimental, it is estimated shooting on this scale throughout the field will add approximately 100,000,000 bbl. to the production of wells already drilled.

Turner Valley.—In north central Turner Valley, Okalta Oils 22, LSD 8, 1-20-3w5, drilled to 4,508 ft. as a test of potential shallow oil horizons above the Madison is testing the McDougall-Segur sand after the Home sand showed only slight traces of oil.

(Continued on page 161)

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KANSAS

Workover Wildcat Becomes Sumner County Discovery

A PREVIOUSLY abandoned wildcat opened a new pool for northeast Sumner County recently when perforations were cemented, and the hole was reperforated. Paul Hatfield and Summit Drilling Co. 1 Bellman, NE NE SW 15-30-1e, the discovery, was reperforated in the top of the Simpson at 3,798-3,804 ft., and operators swabbed 348 bbl. of oil in 48 hours. The well has been assigned a daily potential of 141 bbl. of 51-gravity oil.

Skelly Oil Co. 1 Boggs, NW NW NE 8-33-12w, has opened a new gas producing area in Barber County, about 2 miles east of the Medicine Lodge field. The Mississippi lime was cut at 4,471 ft., and drilled to 4,493 ft. The well yielded 603,000 cu. ft. of gas natural, and tested 3,110,000 cu. ft. after acid. Back pressure was 220 lb.

Completions for the week totaled 44, including 24 oil wells, 5 gas wells, and 15 dry holes, 5 of which were wildcats. New oil wells yielded a total of 19,809 bbl. per day of initial production. Forty new locations were announced, only three of them being wildcats. The three wildcats will be spotted in Rice, Rooks, and Seward counties.

KANSAS WILDCAT FAILURES

Barton County: David G. Gordon 1 Werhahn, SW SW SE 19-19-15w, dry, TD 3,712 ft., Arbuckle 3,660 ft.

Ellis County: Sunray 1 Lang, NE NE SW 4-14-17w, dry, TD 3,579 ft., Arbuckle 3,538 ft.

Pawnee County: Helmerich & Payne 1 Lowery, NW NW NE 25-22-17w, dry, TD 4,257 ft., Arbuckle 4,217 ft.

Rooks County: Doley 1 O'Brien, NE NE SW 27-10-19w, dry, TD 3,670 ft., Arbuckle 3,651 ft.

Sedgwick County: Beech Aircraft 1 Hinkle, SW SE NW 6-27-2e, dry, TD 3,369 ft., Viola 3,350 ft.

FOREST CITY BASIN

ST. JOSEPH, Mo.—O. R. Newcomer et al 1 Zeikle, about 6 miles west of Polo, in C SW NW 27-55n-29w, Caldwell County, Missouri, was drilling below 900 ft. on the west outskirts of the Polo gas pool. Two miles farther west, Todd and Luehring 1 Benson, 1,540 ft. east and 220 south of NW C 30-55n-29w, Caldwell County, was drilling at 260 ft.

Missouri Valley Gas & Oil Co. had a dry hole at 1 Brown in the Prairie Point gas pool of Platte County, Missouri In 1941 the gasser was gaged at 2,250,000 cu. ft. at total depth of 554 ft. It was deepened this fall to 870 ft. with cable tools and to 1,005 with rotary tools. At 1,005 circulation was lost.

J. E. Palensky et al 1 O. O. Wallace, 8 miles northwest of Maryville, C SW NW NW, 10-65n-36w, Nodaway County, Missouri, was drilling at 664 ft. Rotary table elevation is 1,168 ft.

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ROCKY MOUNTAIN

Cambrian Test at Oregon Basin Holds Spotlight

DENVER.—The test of a Cambrian sand in the Deadwood formation showing for a discovery in Pacific Western Oil Corp.-Kirk Oil Co. 5 Connaghan, SW SW SE 29-51n-100w, south dome, Oregon Basin field, in Wyoming, was delayed by a fishing job when the bailer, which was being run to locate the top of the cement, was lost. The corrected total depth is 6,432 ft., and the top of the granite is 6,421 ft. The top of the Deadwood formation is 5,950 ft., and an electric survey indicated mostly sand from 5,950 to 6,350 ft., of which probably 75 to 85 ft. is saturated. Saturation is at approximately 6,290-6,385 ft. The 5½-in. was cemented in the top of the granite and the test will be made through perforations.

This well is attracting unusual attention because of its bearing on future prospecting. Sands in the Deadwood are known to blanket an immense area throughout northern Wyoming not only in the Big Horn Basin, but extending many miles south and east.

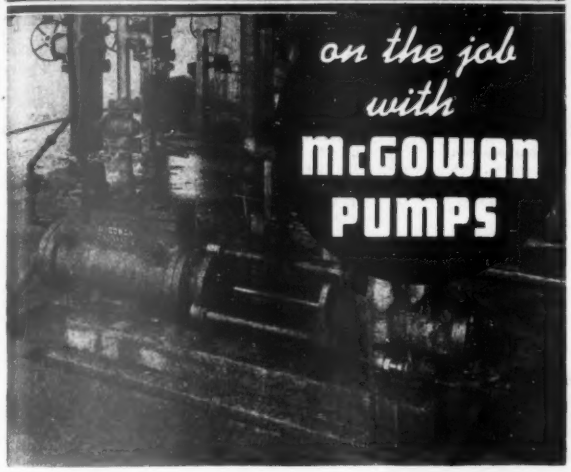
Carbon Dioxide well at Farnham.—Carbon Dioxide & Chemical Co. 1 Government, NW NW SE 12-15s-11e, Farnham dome, Carbon County, Utah, topped the Morrison sand at 3,212 ft. and was completed in that horizon at 3,246 ft. for 5,000,000 cu. ft. of carbon dioxide gas. The well is 1,320 ft. west of Mountain Fuel Supply Co. location for a 6,000-ft. test to the Weber which is waiting on rotary. The gas well will be used to make dry ice. Utah Oil Refining Co. drilled the discovery in the Morrison in 1924.

Big well in Rangely.—Texas Co. 4-29 Union Pacific, C NE SW 29-2n-102w, Rangely field, Rio Blanco County, Colorado, established an initial production record for the field. Completed 3 weeks ago, making 100 bbl. natural first 8 hours, it failed on a production test to make the field allowable and was shot. After shooting it flowed 104 bbl. first 2½ hours, 375 bbl. next 8 hours, 343 bbl. the next 8 hours, and 1,178 bbl. last 24 hours.

North Cut Bank gas well.—A northeast extension of the North Cut Bank gas field to within 4 miles of the Alberta-Montana border was chalked up in Union Oil Co. 1 Haber Unit, NW NW 29-37n-4w, which gaged 19,300,000 cu. ft., open flow at 2,644 ft., total depth, from the Moul-

(Continued on page 162)

GASOLINE PLANTS AND REFINERIES



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UNION CHAINS

LA.-ARK.

New Wesson Field Has Five Active Operations

MAGNOLIA.—The new Wesson field of Ouachita County has five active drilling wells, and has just been given a new producer. The new oiler is McAlester Fuel Co. 1 Allen, SW SW NE 24-15s-19w, which was completed flowing 148 bbl. per day through 10/64-in. choke, with no water. McAlester Fuel has one other well drilling at 3,460 ft., and was the operator of the discovery, McAlester Fuel 1 Wesson. A. B. Turner has one drilling well and one location, Bob Milam has a location, and Lechner & Hill have a location.

Arkansas' only completion this week was a dry hole in Troy field. Completions in the North Louisiana fields totaled 12, including 10 oil wells, and two dry holes. No wildcats were completed. The Big Creek field of Richland Parish took the lead with four completions, two oil and two dry.

OHIO, KENTUCKY

Lorain Gas Pool Gains 3,000,000 Cu. Ft. Well

COLUMBUS.—Wiser Oil Co. 1 A. W. Monosmith, Lot 87, La Grange Township, Lorain County, came in producing 3,000,000 cu. ft. of gas daily nautral Clinton sand was at 2,408-24 ft. A north offset will be drilled.

North of Newark in Newark Township, Licking County, Bucy et al extended their gas pool a location north. The 1 Verne Harris, Lot 10, gaged 942,000 cu. ft. natural from Clinton sand at 2,355-73 ft. Three additional locations for the pool have been approved.

In the town-lot drilling at Stafford, Franklin Township, Monroe County, Sheridan & Hogue found a large volume of gas in the Injun sand which immediately caught fire.

A better than usual well for Liberty Township, Washington County, was completed by Burkhart et al on the C. D. Rake farm, Section 12. Stray lime sand gaged 848,000 cu. ft. with pay at 1,500-05 ft.

Twenty-five locations were reported for the week with 7 in Ashland, and the balance equally divided in the other fields. Of the 33 completions, Cambridge led with 9.

WILDCAT FAILURES IN OHIO

Carroll County, Augusta Township: Smith Petroleum 1 Jas. M. Dager, Sec. 17, lime 3,571 ft., no Oriskany sand, TD 3,900 ft.

Lorain County, Huntington Township: Ohio Fuel 1 C. L. Simonson, Tr. 17, Clinton 2,526-41 ft., 2,590-93 ft., 2,617-24 ft., TD 2,651 ft.

Meigs County, Salisbury Township: Ohio Fuel 1 Alvin Partlow, Sec. 18, Berea 1,704-24 ft., 1,738-42 ft., TD 1,802 ft.

EASTERN KENTUCKY

ASHLAND.—Pike County, with four gas well completions, one topping the million-cubic-foot mark, highlighted the activities in eastern Kentucky during the week.

Kentucky-West Virginia Gas Co. completed 795 Dan J. Syck property, Pike County, total depth 2,800 ft., daily open flow 1,050,000 cu. ft. in shale, natural. Same company completed 796 Ballard Weddington, Pike County, total depth 1,858 ft., daily open flow 502,000 cu. ft. in Maxon, and 5,610 Sam Clark, Johnson County, total depth 3,065 ft., daily open flow 286,000 cu. ft. in shale, after shot. This company also completed 5,613 Farrell & Hatcher, Pike County, total depth 3,530 ft., daily open flow 112,000 cu. ft. in shale and Berea. Inland Gas Corp. completed 286 Viola Conley in Pike County, Barnett's Creek of Paint Creek, total depth 2,415 ft., daily open flow 212,000 cu. ft., Big Six formation.

WESTERN KENTUCKY

OWENSBORO.—Union County had prospects of a new oil pool last week when Joe Engberg 1 Blake Bros., 22-P-20, recovered gas, 120 ft. of clean oil and 102 ft. of oil-cut mud on a 1-hour drill-stem test of the McClosky at 2,564-79 ft. A slight show of oil was also found in the St. Genevieve at 2,531 ft. Operators are now waiting on cement with 5½-in. casing set on the McClosky at 2,573 ft. Total depth of the well is 2,579 ft.

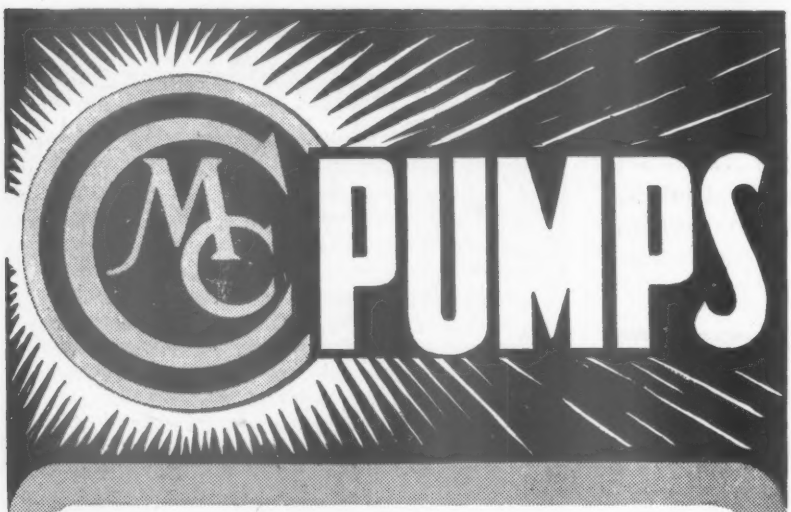
WESTERN KENTUCKY WILDCAT FAILURES

Henderson County: Basin Drlg.-Ohio Oil Co. 1 P. R. Rhodes-H. L. Cokes, 13-Q-20, dry at 2,811 ft., Menard 1,831-38 ft., Viola 1,920-29 ft., Glen Dean 2,064-85 ft., St. Genevieve 2,634 ft., no shows.

Union County: W. E. Stiles 1 Morganfield Coal & Coke, 16-O-20, dry at 2,757 ft., Menard 1,743 ft., Viola 1,922-30 ft., Glen Dean 2,056-76 ft., Golconda 2,178 ft., Barlow 2,349 ft., St. Genevieve 2,607 ft., St. Louis 2,748 ft.

INDIANA

EVANSVILLE.—Interest in Indiana at the present time is centered around the Mt. Carmel East pool in Sections 23, 26 and 27 of 1s-12w, where good wells are being completed in the Hardinsburg sand at approximately 1,800 ft. and in the Cypress sand at about 1,975 ft. Completed wells



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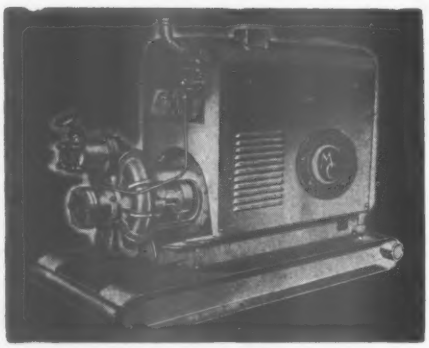

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average from 100 to 200 bbl. of oil a day initially. None of the wells has been deepened below the Cypress sand.

Three completions were recorded in Indiana during the past week, two being dry holes and one a small oil well with an initial production of 25 bbl. daily.

OKLAHOMA

Lincoln County Wildcat May Open New Field

NORTHEASTERN Lincoln County had prospects of a new producing area at the close of the week when Roy L. Kemp 1 Brown, SW NW SE 20-16n-5e, flowed 5 to 10 bbl. of 40-gravity oil an hour along with an estimated 5,000,000 cu. ft. of wet gas. The 1 Brown was drilled to 4,022 ft. in the Mississippi lime and was plugged back to 3,485 ft. in the top of the Verdigris after the lower lime failed to produce. Five-inch casing was cemented at 3,375 ft., and the well headed, cleaned the hole and flowed when plug was drilled. Present production is from the Prue sand.

Another Lincoln County wildcat, Aladdin 1 Young, NW SW NW 32-12n-3e, was successfully completed during the past week to open the South Winn pool. The 1 Young pumped 19 bbl. of oil daily from the Bartlesville sand at 4,855-72 ft., total depth 5,764 ft.

Deep Rock Oil Corp. et al 1 White, SW NE NE 19-23n-2w, has definitely opened a new oil producing area in Noble County. The new producer made 462 bbl. of oil in 11½ hours when plug was drilled and was making 40 bbl. an hour when final gages were taken before closing the valves. It is producing from the Wilcox sand at 4,433-50 ft. Test was made through 2-in. tubing and a 50-lb. back pressure was registered on the separator during the test.

Carter 1 Hawkins, NE NE 34-6n-3w, erroneously reported as a wildcat failure the previous week, is being plugged back to test all zones. Originally drilled to the Bromide, the 1 Hawkins found that formation dry and was plugged back to test the Hunton lime through perforations at 8,222-24 ft. However, operators started recovering salt water and the perforations were squeezed off. The well will be perforated again to test the same zone before it is plugged back to more shallow formations.

OKLAHOMA SUCCESSFUL WILDCAT
Lincoln County: New oil pool, South
(Continued on page 161)

Drilling Under Way at North Carolina Test

Drilling operations are now under way on the first of the Standard Oil Co.'s exploratory wells on its 2,000,000 acres of oil-leased lands in North Carolina. This first well is located at the Hatteras lighthouse near Buxton, on the basis of seismograph findings. No information has been released concerning the depth of the well but the equipment being used is capable of carrying the test down to 15,000 ft. Drilling operations will be slow, with a core being taken every 50 ft. on the way down. Noble Drilling Co. is contractor for the test.

An exploratory well located in Kittson County, Minnesota, and financed by farmers and business men of that county, is apparently a failure. Drilling was stopped after approximately 20 ft. of granite formation had been penetrated. The granite was reached at a depth of 600 ft. Additional exploration may be undertaken in the area.

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Other Goodall products for the Petroleum Industry include Oil Suction and Discharge Hose; Tank Car Unloading, Tank Truck and Curb Pump Hose; Air, Steam, Acid and Sand Blast Hose; Belting; Clothing for field, plant and laboratory.

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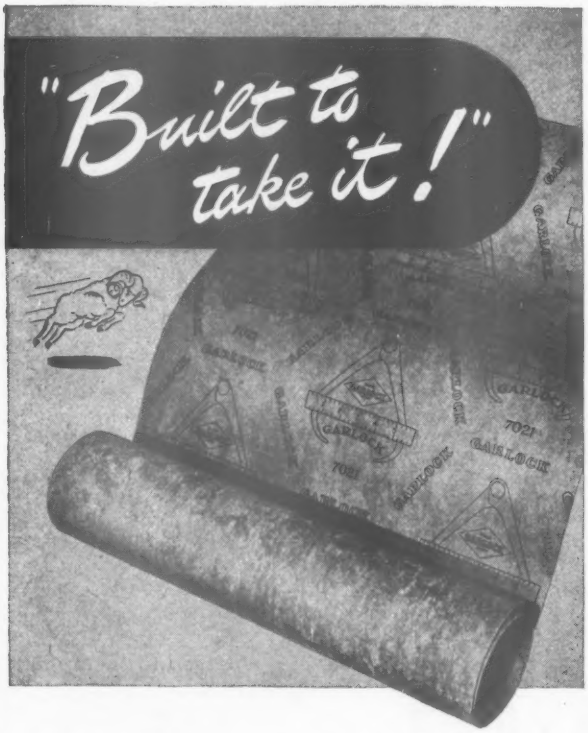

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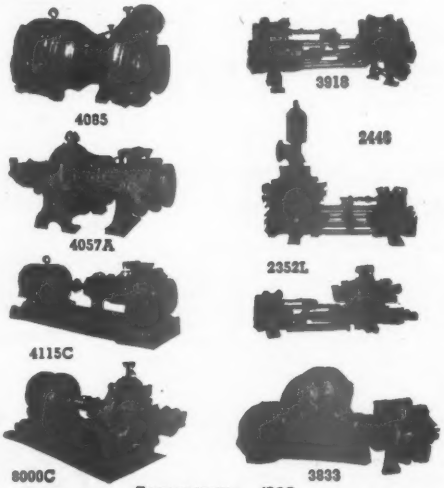

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PERMIAN BASIN

Devonian Discovery Completed in Andrews

MIDLAND.—Mid-Continent Petroleum Corp. 1-15 University, Section 42, Block 13, University lands, latest Devonian discovery for Andrews County, has been completed, flowing 1,427 bbl. of oil in 24 hours. Gas-oil ratio was 1,553 to 1. Production is through perforations from 8,590 to 8,650 ft. Devonian was topped at 8,540 ft. The discovery is 2 miles south of the Fullerton pool, separated from the proven reservoir by a dry hole. Three and one-half miles south, Magnolia Petroleum Co. 2 Joseph Martin, Section 12, Block A-47, Public School Lands, scheduled 12,000-ft. wildcat, was drilling below 8,782 ft. in chert. Elevation is 3,290 ft. Sinclair Prairie Oil Co. 1 H. G. Bedford, Section 10, Block 73, Public School Lands, 1 mile southeast of the Bedford pool, southwestern Andrews County, ran a 75-minute drill-stem test from 11,434-78 ft. Recovery was 90 ft. of drilling mud with no shows. Operator was drilling ahead.

Stanolind Oil & Gas Co. 1 Williamson, Section 5, Block 45, T-1-N, T&P Survey, wildcat northwest of the Goldsmith pool, Ector County, made a 1-hour drill-stem test from 8,378 to 8,475 ft., and recovered 85 ft. of drilling mud with no shows. Stanolind and Landreth Co. 3-Q Scharbauer, Section 12, Block A, Public School Lands, wildcat on the north end of the Goldsmith pool, showed some new oil while cleaning out at 8,067 ft. The well had been shot with 305 qt. from 8,000-10 ft.

Humble Oil & Refining Co. 1 G. H. Cowden, Section 35, Block X, CCSD&RG NG Survey, southeastern Crane County wildcat, 6 miles southwest of Crane, recovered 358 ft. of drilling mud with no shows on a 58-minute drill-stem test from 9,014 to 9,260 ft. Operator was preparing to core from total depth of 9,298 ft. Humble 1 Tucker, Section 23, Block 1, H&TC Survey, wildcat 1½ miles west of the McKee pool, Crane County, took a 28-minute drill-stem test from 5,679 to 5,734 ft. Gas came to the surface in 2 minutes and maintained a steady blow throughout. Recovery was 25 ft. of drilling mud and 2 ft. of brown distillate. Gas was estimated at 7,000,000 cu. ft. daily.

F. A. Callery 6 Shannon, Section 27, Block WX, GC&SF Survey, has become the largest Ellenburger well in the Todd Deep field of western Crockett County. On official test it flowed 4,008 bbl. of 41.8° gravity oil in 24 hours. The well marks a ¾-mile extension to Ellenburger production in the pool. Stanolind will drill an 8,500-ft. wildcat in extreme southwestern Hale County less than ½ mile from the Lubbock County line. It is 1 Lee Irish, 660 ft. out of the northeast corner of Section 18, Block DT, HE&WT Survey. The test will be about 5 miles due east of the Anton field discovery in Lamb County. Globe Oil & Refining Co. 1 Downs, Section 5, Block JK, T.T. Survey, Hale County wildcat 8 miles northwest of Plainview, was drilling below 5,510 ft. in dry lime.

Fullerton field, Andrews County; Iataan-East Howard, Howard County; White and Baker field, Pecos County, and Keystone-Ellenburger field, Winkler County, each had two completions this week. Sharon Ridge field, Scurry County, reported five new locations and the Keystone area, Winkler County, three.

SUCCESSFUL WILDCAT COMPLETION FOR WEST TEXAS

Crane County: New oil pool—Atlantic 1-A University, Sec. 33, Blk. 31, University Lands, 7 mi. NW Crane, elev. 2,551 ft., dual completion, flowed 776 bbl. day through ½-in. choke on 2-in. tubing, perf. 8,812-27, 8,835-42, 8,860-69 ft. Devonian, gravity 47.3, gas-oil oil ratio 700 to 1; flowed 414 bbl. day through ½-in. choke on 2-in. tubing, perf. 10,291-458 ft. Ellenburger, gravity 47.2, gas-oil ratio 550 to 1, TD 10,458 ft.

WILDCAT FAILURES COMPLETED IN WEST TEXAS

Crane County: John I. Moore 1 Southland Royalty, Sec. 19, Blk. 2, H&TC Sur., 6 mi. SE Sand Hills field, elev. 2,423 ft., Silurian 6,890 ft., Simpson 7,235 ft., dry, TD 8,009 ft.

Ector County: A. P. Carr 1 Pauline Slator, Sec. 4, Blk. 42, T-4-S, T&P Sur., 12 mi. S Odessa, elev. 2,928 ft., dry in Grayburg, TD 5,006 ft.

Loving County: Argo Oil Co. 1 Evelyn Lineberry, Sec. 13, Blk. 75, PSL Sur., 17 mi. NW Wink, elev. 3.055 ft., Delaware 5,188 ft., dry, TD 5,253 ft.

SOUTHEASTERN NEW MEXICO

HOBBS.—Southern Union Gas Co. will drill 1 English, a 5,000-ft. wildcat in west central Lea County. It is 1,980 ft. from the south line and 660 ft. from the west line of 26-18s-33e. The test is between the Corbin and Tonto pools and 3 miles from the nearest production.

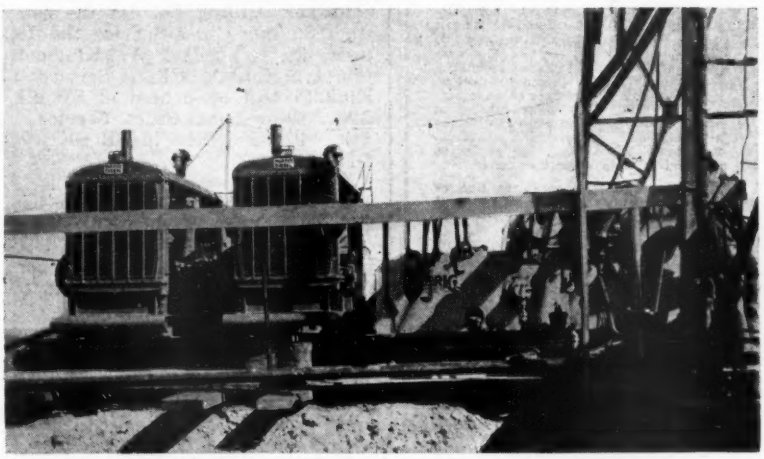
Humble Oil & Refining Co. 1 Cooper, 23-24s-36e, scheduled 7,500-ft. test in the shallow Cooper field of southeastern Lea, was drilling below 6,189 ft. in lime and chert. Humble 8 Greenwood, 9-22s-37e, south outpost to Neville G. Penrose, Inc. 1 Penrose, eastern Lea County discovery, was drilling below 6,929 ft. in lime.

Paddock field, Lea County, and Turkey Track field, Eddy County, each had one field completion. Lea County reported three new field locations.

SUCCESSFUL WILDCAT COMPLETION IN SOUTHEASTERN NEW MEXICO

Lea County: New oil pay—Neville G. Pen-

(Continued on page 157)



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Among the Drilling Contractors

Crow Drilling Co. will drill the Gulf Refining Co. 4 Wausau Southern Lumber Co., 766 ft. south and 765 ft. west of NE cor. NW NE 12-9n-9w, in the Eucutta field of Wayne County, Mississippi.

Parker Drilling Co. has the contract for two Cities Service Oil Co. tests to be drilled in Kingman County, Kansas. Cities Service 1 Kinkaid will be drilled in SW SE SW 8-29-5w, and Cities Service 1 Eck will be drilled in SE SE NW 1-29-10w.

A. W. Hutchings Drilling Co. has the contract for Premier Oil Refining Co. et al 1 McKinley, 690 ft. north and 390 ft. east of SW cor. NW SW 26-9n-12w, a wildcat in Jones County, Mississippi.

Beardmore Drilling Co. will drill the Bay Petroleum Co. 1 Bolton "A," SE SE NE 10-19-8w, in Rice County, Kansas.

Bullington & Holloway Drilling Co. is preparing to spud in Kerlyn Oil Co. 1 Pate, SE of Lot 144, Land District 13, Crisp County, Georgia.

Parker Drilling Co. is the contractor for Danciger Oil & Refining Co. 1 Armstrong, a wildcat in 5-4n-2w, Wilkinson County, Mississippi.

Lyle Cashion, Ltd., is the contractor for Gulf Refining Co. 1 Berry, 678 ft. south and 657 ft. east of NW cor. SE NW 13-9n-19w, in the Gwinville field of Jeff Davis County, Mississippi.

Cox Drilling Co., Owensboro, Ky., has the contract for Chester Oil Co. 3 Hunt, 330 ft. from the south and 990 ft. from the west line of SW NW 16-1s-9w, Gibson County, Indiana.

Higgenbothan and King will drill the M. E. Holloway and Raymond W. Whyte 1 Jankowski, NW SE SE 23-19n-4e, in the Deep River field, Arenac County, Michigan.

N. V. Duncan, Fairfield, Ill., has the contract for Walter Duncan 3 Macke, SW SE NW 23-12n-7e, in Coles County, Illinois.

Muskegon Development Co. is the contractor for Chapman Oil Co. 4 Ruegsegger, S½ N½ 3-14n-4e, in the Kawkawlin field of Bay County, Michigan.

George & Wrather, Mount Carmel, Ill., will drill the John Wrather 1 Thompson, SE SE SE 15-15n-2w, a wildcat in Christian County, Illinois.

Union Rotary and **Muskegon Development Co.** will drill the Chapman Oil Co. 1 Jenk, N½ SE SE 12-16n-8w, in the Fork field of Mecosta County, Michigan.

George & Wrather, Mount Carmel, Ill., is the contractor for Blackhawk Coal Corp. 1 Burkett et al, 1,077 ft. from the north line and 990 ft. from the west line of NW NE 27-1s-12w, in Gibson County, Indiana.

Andrew S. Hoyt is the contractor for Arthur J. Boeve 2 Plaggemer, SE SW SW 27-5n-15w, in the Fillmore field of Ottawa County, Michigan.

Contractors Ask Lower Drilling Insurance Rates

Readjustment of insurance rates for the drilling industry is being sought by the American Association of Oil Well Drilling Contractors, and was the objective of a conference held in Dallas last week between the association's insurance committee and representatives of insurance companies. Chief aims of the com-

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mittee are lower rates, more extensive coverage, uniform rates as to jobs, type of equipment, etc.

The association's safety workers met with the insurance committee to point out the reduction of hazards and risks, resulting from one of the most extensive safety programs undertaken by the drilling industry. William Broadhurst, vice president of Helmerich & Payne, Inc., Tulsa, chairman of the association's insurance committee, pointed out that the present situation is not the fault of the insurance companies or of the contractors, but comes from the lack of the right kind of cooperation between the two groups. He expects last week's conference to lay a basis for future cooperation.

CALENDAR

Western Oil and Gas Association, annual meeting and business conference, Biltmore Hotel, Los Angeles, December 19.

1946

January

SAE, annual meeting, Book-Cadillac Hotel, Detroit, January 7-11.

FPC regional hearing in natural-gas investigation, Court House Building, Houston, January 28.

Independent Natural Gas Association of America, annual membership meeting, Texas State Hotel, Houston, January 28.

February

American Welding Society, national meeting, Hotel Cleveland, Cleveland, February 4-7.

Iron and Steel and Institute of Metals divisions, American Institute of Mining and Metallurgical Engineers, national meeting, Statler Hotel, Cleveland, February 4-8.

American Society for Metals, annual convention (postponed from 1945), Statler Hotel, Cleveland, February 4-8.

FPC regional hearing in natural-gas investigation, Buena Vista Hotel, Biloxi, Miss., February 11.

FPC regional hearing in natural-gas investigation, Chicago, February 19.

American Society for Testing Materials, spring meeting, Pittsburgh, February 25-March 1.

Exposition of Chemical Industries, twentieth exposition, Grand Central Palace, New York, February 25-March 2.

March

FPC regional hearing in natural-gas investigation, Charleston, W. Va., March 19.

Southern Gas Association, annual convention, Galveston, March 21-22.

April

American Association of Petroleum Geologists, annual meeting, Stevens Hotel, Chicago, April 2-4.

Natural Gasoline Association of America, annual convention, Baker Hotel, Dallas, April 17-19.

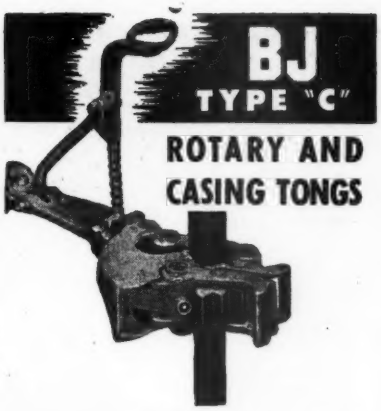
National Petroleum Association, semi-annual meeting, Hotel Cleveland, Cleveland, Ohio, April 18-19.

May

National Association of Corrosion Engineers, annual meeting, President Hotel, Kansas City, Mo., May 7-9.

June

American Society for Testing Materials annual meeting, Buffalo, June 24-28.



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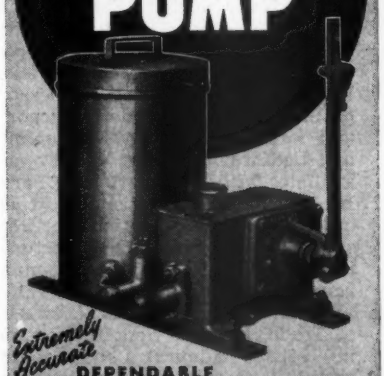

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PERSONALS

Managed Jersey's Tanker Fleet During War

BUSHROD BRUSH HOWARD, recently elected a director of Standard Oil Co. (New Jersey), has been associated with Jersey's big tanker fleet since he joined the company in 1920 and he was general manager of its marine group throughout the war.

Howard was born in 1889 at the Naval Academy, Annapolis, where his father, Adm. Thomas Benton Howard, was stationed. Graduating from the academy in 1911, he was in the Navy during World War 1, leaving the service in 1919 with the rank of lieutenant commander. Upon entering Jersey's operating division Howard became managing operator of Societe Auxiliare de Transports and later director of l'Economique and Bedford Petroleum Co., French affiliates with headquarters in Paris. In 1929 he went to London to coordinate marine operations for Jersey's Standard Shipping Co., returning in 1934 to become assistant manager of marine operations.

At the request of the British Board of Trade, Howard went to England in 1941 as Admiral Land's representative to expedite tanker turnarounds in British ports and to speed up oil deliveries from the United States. In 1942 he went to India as a representative of War Shipping Administration, to expedite cargo movements. He is president of War Emergency Tankers, Inc.

Donald B. Thurman, former lieutenant colonel with the AAF in the China, Burma, Indian Theater, has joined the marketing council department of Standard Oil Co. (N.J.). He will assist in the coordination of marketing procedures and advertising programs of foreign and domestis affiliates of the company.

Col. Verne Austin, Cavalry, formerly a petroleum engineer with the California Division of Oil and Gas, has been awarded the Legion of Merit for conspicuous service while in command of the Japanese segregation center at Tule Lake, Calif., where disloyal Japanese were confined. In November 1943, owing to riots and other disturbances, the Army took over the administration of the camp and reestablished order. In February 1944, after the escape of German prisoners of war from Papago Park Camp, Phoenix, Ariz., Colonel Austin was placed in command of that installation. He will soon be released and is expected to return to California.

Ross C. Kimball, Sherman, Tex., for years active in drilling projects in the North Texas area, has qualified in geology and has been registered with the National Roster of Scientific and Specialized Personnel, maintained to provide the federal Government with a list of skilled persons who may be mobilized if needed.

James A. Hall, after 4 years in the Army, has returned to the Texas Railroad Commission as petroleum engineer in the Midland office.

Paul J. Parker, staff attorney for Phillips Petroleum Co. at Bartlesville, Okla., has been elected assistant secretary and assistant treasurer. Parker received his A.B. and LL.B. at Kansas University.

Oliver G. Morgan, released from the Navy, is in charge of the new office opened in Midland, Tex., by Helmerich & Payne, Inc., of Tulsa.

Ben Harwit, scout for The Texas Co., has been transferred to Midland, Tex., from Fort Worth.

A. C. Stewart, vice president of Union Oil Co. of California, has been appointed chairman of the metropolitan district, commerce and industry section, for the 1946 Los Angeles Red Cross fund, and **Clarence S. Beesemyer,** vice president of General Petroleum Corp., has been appointed chairman of the petroleum section.

Paul Sanders, formerly refinery foreman for General Petroleum Corp., has been advanced to refinery superintendent and **W. M. Manley** has been promoted to assistant refinery superintendent. **D. G. Baldwin,** who was foreman of the grease, lube, and blending plants, is now superintendent of those units.

William C. Frysinger and **John D. Kurtz** have returned to their duties as executives in the foreign sales department of The Atlantic Refining Co. after wartime service with Petroleum Administration for War as assistant directors of the foreign supply and distribution division, charged with expediting shipment of petroleum products abroad.

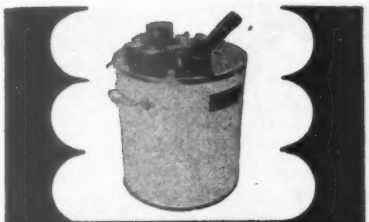
Thomas S. Johnston has been appointed manager of the marine departments of Imperial Oil, Ltd., and International Petroleum Co., Ltd., succeeding **H. J. Rahlves,** who is retiring from active service. Johnson was formerly associated with Standard Oil Co. (N.J.) in New York.

A. C. Cockrill, divisional sales manager for British-American Oil Co. at Calgary for 3 years, has been transferred to Toronto as national director of personnel. He is succeeded at Calgary by **J. W. Sanford,** for 10 years in the Calgary branch.

Dr. Joseph Paynter Holt, former associate professor of physiology at University of Louisville, has joined Standard Oil Co. (N.J.) as a specialist in toxicology. He will be responsible for original research in the biological effects of toxic substances. Jersey Standard is the first oil company to undertake its own work in this field.

H. R. Gillespie, formerly traffic manager for Deep Rock Oil Corp., has been promoted to general traffic manager. His office will continue to be in Chicago. He joined Deep Rock in 1919.

J. E. Rouse, formerly with Standard Oil Co. (Indiana), will be manager of a manufacturing department which Stanolind Oil & Gas Co. is to install January 1. Rouse, with head-



ACCURACY

Foremost requirement of a gravity survey is ACCURACY. Actual field operations by unbiased operators as well as by our own Gravity Meter Parties disclose that the North American Gravity Meter definitely meets this requirement. In one survey, a group of Base Stations checked within .01 of a milligal of the original values, established a year earlier by a different North American Gravity Meter.

Many years of experience in the design and construction of gravity meters, their field operation and interpretation of data obtained have led to the development of the present highly accurate North American Gravity Meter.

NORTH AMERICAN
GEOPHYSICAL COMPANY
Gravity . . . Seismic Surveys
Geophysical Apparatus
636 Bankers Mortgage Building
Phone Charter 4-3523 HOUSTON 2, TEXAS

ST. LOUIS SNAPSHOTS

HE GETS
ALL THE BREAKS...
HE HAS A ROOM
AT THE HOTEL

Mayfair
EIGHTH AND ST. CHARLES

quarters in the company's main offices in Tulsa, will have charge of all technical matters relating to proposed gasoline, cycling, and repressuring plants, and will be responsible for sales of all manufactured products and for purchases and sales of gas.

J. R. Lynch, discharged from Air Corps service, has rejoined Standard Oil Co. of Texas as scout at Midland, Tex.

Sam W. Wells has been transferred by Ashland Oil & Refining Co. from Evansville, Ind., to Owensboro, Ky., where he has charge of the geological exploration department.

Frank S. Parker, former senior petroleum geologist, District 5, for the Petroleum Administration for War, has joined the geological staff of the Signal Oil & Gas Co. He will make geological studies and evaluations of prospects as a part of Signal's expanding program of active exploration. From 1934 to 1940 he was geologist for the Shell Oil Co. in California, Kentucky, and parts of Canada. In 1940, he became associated with the Wilshire Oil Co., where he remained until 1943, when he became senior geologist for the PAW specializing in work which involved estimates of oil reserves of California and the progress of exploratory drilling and research during the war period.

C. J. Wilhelm, who was supervising engineer of the Franklin, Pa., petroleum field office of the Bureau of Mines, petroleum and natural gas division, has been named petroleum engineer at the Bartlesville, Okla., petroleum experiment station. **Sam S. Taylor,** formerly assistant supervising engineer at Franklin, has been moved up to take Wilhelm's place. At Bartlesville Wilhelm succeeds **R. E. Heithecker,** who resigned to enter private industry. Wilhelm, a graduate of Pennsylvania State College, joined the Bureau of Mines in 1929. Taylor is a University of Alabama graduate.

Southeastern New Mexico

(Continued from page 153)

rose, Inc., 1 Jones, 6-22s-38e, Paddock pool, elev. 3,360 ft., flowed 187 bbl. day through 5/16-in. choke on 2-in. tubing, perf. 7,040-7,160 ft. Yeso, TD 7,205 ft.

WILDCAT FAILURES COMPLETED IN SOUTHEASTERN NEW MEXICO

Lea County: Carl B. King Drlg. Co. 1 Santa Fe, 29-9s-37e, elev. 4,000 ft., 4 mi. S of N line of county, San Andres 4,170 ft., dry, TD 4,986 ft.

Stanolind 1 Masco Unit-State, 31-21s-34e, 4½ mi. SW Eunice field, elev. 3,653 ft., Yates 3,950 ft., dry, TD 4,308 ft.

PROTECT
Valuable Equipment
with
ADSCO
STRAINERS and SEPARATORS

Prevent shutdowns — prolong the life of equipment—increase operating efficiency with Adsco Strainers and Separators.

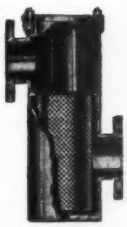
THE Y TYPE STRAINER protects traps, regulators, valves and other equipment from the wearing and destructive effect of foreign matter.

THE SUCTION STRAINER does likewise for pumps and other heavier equipment where bulk liquid is contaminated with foreign matter.

ADSCO SEPARATORS

remove oil and water from steam—deliver dry steam to engines, turbines and other steam consuming equipment increasing its efficiency and protecting it from damaging water slugs.

Y TYPE STRAINER—screen held in place by removable plug that permits easy removal for cleaning—sizes from ½" to 2".



SUCTION STRAINER
Basket has handle. To clean it, simply remove cover at top and pull it out.

HORIZONTAL TYPE

VERTICAL TYPE for either up or down flow.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA NEW YORK
Makers of UP-TO-DATE Steam Line Equipment for Over 65 Years

E. L. DECKER

TUT LEE

E. E. BAKER

W. S. HAMMOND

R. E. KRAMER

AL PRANGER

Equipment Men in News

E. L. Decker, vice president of Martin-Decker Corp., Long Beach, Calif., has just returned from an extensive sales trip throughout the Mid-Continent and Gulf Coast territories. He attended the Oklahoma contractors meeting and the divisional managers meeting of Reed Roller Bit Co. at Tulsa. His itinerary included Shreveport, La.; Houston and Fort Worth, Tex.; Natchez and Laurel, Miss.; Southern Louisiana and West Texas.

H. W. Acason, manager of the Western division of Climax Engineering Co., has announced the appointment of **Tut Lee** as manager of oil-field sales for Climax Engines & Parts Co., Los Angeles, southern California distributor. Lee has resigned from International Derrick & Equipment Co., of Los Angeles, to become associated with Climax.

Howard R. Ryan, general sales manager, Economy Pumps, Inc., Hamilton, Ohio, announces the appointment of **E. E. Baker** as manager of distributor sales division. Baker was district manager of the Pomona southern district and was manager of the Fairbanks-Morse Pump Division in Boston.

W. H. Hammond has been promoted to the newly created post of vice president in charge of sales of Gar Wood Industries, Inc., Detroit, it is announced by **Glen A. Bassett,** president. Hammond was formerly sales manager of the hoist and body and tank divisions only and director of branches with the title of vice president.

Election of **Ralph E. Kramer** to vice president in charge of sales of Hammond Iron Works, Warren, Pa., is announced by **R. Y. Kopf,** president. Kramer brings to Hammond Iron Works 23 years of diversified export and domestic industrial experience in mining, construction, engineering and development.

Al Pranger has returned to active duty as sales manager of The Guiberson Corp. after 3 years with the Armed Forces, according to an announcement by **W. W. Finlay,** executive vice president and general manager of the company.

Lynn Sawyer, vice president and general manager of the Pump Division of Byron Jackson Co., Los Angeles, accompanied by **O. W. Morgan,** sales manager, Oil Tool Division, and **Robert Harcus,** foreign representative, left La Guardia Field, New York, on November 20 via Pan American Airways, for an extended visit in England and the continent. They will consult with hydraulic and petroleum engineers in England, France, Belgium, and the Netherlands concerning future requirements

Frank Miller, the "Dean of the Rubber Industry," is pictured receiving a service pin award from President Thomas Robins, Jr., in recognition of his 50 years with Hewitt Rubber Corp. Miller is a vice president in Hewitt's Chicago office. Others (left to right) who received awards at the company's recent testimonial dinner in Buffalo: Joseph Kamrowski, stock cutter, 35 years; William Bauer, machinist, 35 years, and Charles Paeplow, consulting engineer, 40 years. Robins reminded the "Oldtimers" that 203 employes have been with the company 10 years or longer

ROBERT HARCUS

O. W. MORGAN

LYNN SAWYER

for centrifugal pumps, submersible motors, oil-well drilling and production tools.

International Harvester Co. will use the former Buick aviation engine plant at Melrose Park, Ill., Chicago suburb, for expanded production of its industrial power line of products, it is announced by **H. T. Reishus,** general manager of the company's industrial power division.

C. Earle Stewart, Williamstown, W. Va., has been appointed drill sales representative, according to an announcement made by Bucyrus-Erie Co., South Milwaukee, Wis. He will assist **H. C. Neely,** drill sales representative for the Evansville, Ind., sales district, in serving central, south central, and southeastern states.

Three returning veterans, all formerly associated with various divisions of American Brake Shoe Co., have joined the company's export division as sales representatives, **S. F. Brown,** director of exports, announced. **Robert Beecken** was formerly local purchasing agent for the Ramapo Ajax Division. **Hugh Hazleton** was a sales representative for the American Brakeblok Division. **William Van der Kieft** originally came to Brake Shoe in 1939.

Ray L. Morrison will head up the new Brake Division of The Timken-Detroit Axle Co., it is announced by **Walter F. Rockwell,** president. Previous to his new connection, Morrison was vice president and general manager of Bendix-Westinghouse Automotive Air Brake Co. **Ralph K. Super,** for the past 6 years brake engineer for Timken Axle, will serve the newly formed unit in the capacity of Brake Division engineer.

Max L. Murdock, who recently left the U.S. Navy with the rank of lieutenant commander, has been appointed assistant manager of the centrifugal pump section at the Allis-Chalmers Norwood (Ohio) Works, according to **H. P. Binder,** centrifugal pump department manager.

Appointment of **Robert C. Allen, Jr.,** as manager of the Kansas City, Mo., factory branch was recently announced by **J. F. Ray,** director of sales, General Controls Co., Glendale, Calif.

Following consummation of a deal as of December 1, forming Maloney-Crawford Tank and Manufacturing Co. as successor to Maloney Tank Manufacturing Co., Harold Crawford, secretary-treasurer of the new firm, and O. W. Maloney, president, inspect part of the stock of bolted steel tank plates in the firm's Tulsa plant.

HELP WANTED

WANTED: Production Supefvisor, take charge of oil and gas production, superintend drilling of 7,500-foot oil and gas wells in East Texas for progressive independent operator. Must have proven ability to manage and operate difficult property. Job will be open December 15th. Box A-905, The Oil and Gas Journal, Tulsa, Oklahoma.

SALES REPRESENTATIVE covering Houston and Gulf Coast, as added item, a device of 5 years' acceptance with drilling and production. Unusual opportunity for qualified man. Write Box A-910, The Oil and Gas Journal, Tulsa, Okla.

WANTED: TELEGRAPH OPERATOR Not over 37 years; with good education, preferably college; with pipe line experience, capable of advancement in pipe line company's oil dispatcher's office; location, Tulsa. Box A-736, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Observers, engineers, shooters, and computors, for domestic seismograph work. Good future, permanent employment for those qualified. Box A-890, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Administrative assistant familiar with oil field drilling and production operations and materials and office procedures to assist in cooperative work. Graduate engineer preferred but not necessary. Give complete history of previous and present work and salaries received and expected, with references. All replies will be kept confidential. Address Box A-895, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Graduate Mechanical Engineer having at least 6 to 10 years refinery experience, design, maintenance and construction. Box A-901, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Expert cementer of oil and gas wells. Monthly salary plus expenses. Steady job for sober and dependable man. Standard Cementing & Mudding Co., 110 Federal Square Bldg., Grand Rapids 2, Michigan.

WANTED: By The Superior Oil Company young men with college background in electronics. Single men preferred. Write P. O Box 96, Bakersfield, California. Apply 1425 Union Ave., Bakersfield, California.

WANTED: By The Superior Oil Company young men with college background in geology. Single men preferred. Write P. O. Box 96, Bakersfield, California. Apply 1425 Union Ave., Bakersfield, California.

WANTED: MINING OR PETROLEUM ENGINEER by Major Oil Company. Recent graduate or with some experience, for Exploitation and Production Engineering work. Training course if inexperienced. Write Box A-799, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: MECHANICAL ENGINEER. Major Oil Company requires graduate Mechanical Engineer for Production Department. Either experienced or inexperienced. Write Box A-800, The Oil and Gas Journal, Tulsa, Oklahoma.

SITUATIONS WANTED

HOW TO SELL THE CHICAGO AND MIDDLE WESTERN MARKET

Live wire sales representative with 15 years successful background, available to a manufacturer of Malleable and Cast Iron Pipe Fittings, Steel Pipe Nipples, Cast Iron Soil Pipe or Copper Tubing and Brass Pipe. I have orders on hand, also a very broad acquaintance with key buyers of, and major users of, these products in this territory, and my sound sales plan will assure maximum results. If your company has these meritorious products and is deserving of optimum sales distribution, it will pay you to consider strongly my comprehensive sales-representation for your coverage of this territory. Can give you a minimum guarantee of set dollar volume or you need not pay me one penny commission if I fail to meet quota during 90 day trial period. Write or Wire Box A-903, The Oil and Gas Journal, Tulsa, Oklahoma.

SITUATIONS WANTED

SALES REPRESENTATIVE: Veteran, 34, Pet. & Nat. Gas Eng. grad. having sales, engineering and executive experience desires to represent manufacturers of established products selling to Oil and Gas Production, Refining and Transportation Industries in Mid-Continent area. Reply Box A-853, The Oil and Gas Journal, Tulsa. Oklahoma.

WANTED: SUPERVISORY OR ENGINEERING work in Construction or Maintenance Instrumentation. Background; Mechanical Engineer Graduate with seventeen years in Oil Refining Industry. Familiar with most all makes of instruments. O. S. Calhoon; Hinsdale, Illinois.

GEOLOGIST with 8 years experience in petroleum geology and paleontology domestic and foreign wants position as paleontologist for major oil company operating in South America or Far East. Salary $500 month and living quarters for family available. Box A-898, The Oil and Gas Journal, Tulsa, Oklahoma.

GRADUATE Electrical and Radio Engineer; age 38, with 17 years experience, desires position with oil or gas company. Box A-572, The Oil and Gas Journal, Tulsa, Oklahoma.

EX-NAVAL AVIATOR, age 27, University of Notre Dame graduate, licensed commercial pilot; desires position with person or corporation, preferably as pilot and executive assistant. Ambitious, reliable. Excellent references. South America considered. Box A-900, The Oil and Gas Journal. Tulsa. Oklahoma.

EXPERIENCED REFINERY construction and operator desires position in small progressive refinery with option to purchase interest. Box A-904, The Oil and Gas Journal. Tulsa, Oklahoma.

PURCHASING AGENT desires permanent position with major or well established independent company. Thoroughly experienced in purchasing organization, procedure, handling people, assuming responsibilities, and very familiar with machine tools. Age 29, University, and now employed as Purchasing Agent by large Industrial and Mill Supply Co. Available two weeks. Salary $350.00. Box A-906, The Oil and Gas Journal, Tulsa, Oklahoma.

GOOD SALESMAN. College graduate. Over 10 years experience in Petroleum Engineering. Perfect command of Russian Language. Seeks connection with a firm dealing with the Russians. Box A-908, The Oil and Gas Journal, Tulsa, Oklahoma.

REFINERY SUPERINTENDENT: Thirty years' experience in construction and operating skimming, cracking, polymerization units; also gasoline plants. Would like to make connection with independent company in southwest. Can furnish best of references. Available January 1st. Box A-914, The Oil and Gas Journal. Tulsa. Oklahoma.

SALES: Process engineer desires position engineering sales or equipment sales Gulf Coast-Texas-Oklahoma. Experienced engineering management and over-all refinery planning, and thoroughly competent in both process and mechanical design of refinery processing plants, fractionating towers, oil heaters and cracking furnaces. Experienced in atmospheric and vacuum distillation, thermal and catalytic cracking and reforming, gas absorption, fractionation, polymerization, and alkylation. Capable in selection and application control instruments, heat exchangers, pumps, compressors, turbines, boilers, cooling towers, and miscellaneous equipment. Experienced also in shop fabrication of pressure vessels, heat exchangers, piping, structural steel, in design and erection steel and concrete structures, foundations, and in field construction of process plants. Registered Texas professional engineer. Age 33. Box A-913, The Oil and Gas Journal. Tulsa, Oklahoma.

IN PETROLEUM TESTING laboratory. 9 years' experience engine testing in research and refining laboratories. CFR knock engine operator capable of operating, maintaining and supervising all test methods. Excellent references. Available immediately. Box A-912, The Oil and Gas Journal, Tulsa, Oklahoma.

MECHANICAL ENGINEER—Lt. Comdr., U.S. Navy, just released with varied and intensive experience in the design of heavy machinery and engineering research in oil production, machinery and equipment. Interested only in serious undertaking and permanent status. Locate temperate climate. Salary $4000-$5000. Address Box A-909, The Oil and Gas Journal, Tulsa, Oklahoma.

SITUATIONS WANTED

SITUATION WANTED: Veteran separated as major, 31 years old, married, B.S. degree in Mining Engineering. Have 2½ years experience with gravity meter crew. Prefer Geological or Production work. Short training course desirable after 5 years in service. Box A-891, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER and Rotary Driller desires position with producing or drilling company or oil tool manufacturing company. Nine years with major company. Three years Naval Officer at repair shipyard. Age 35. Box A-863, The Oil and Gas Journal, Tulsa, Oklahoma.

ROYALTIES

ANDREW J. BARRETT
The Philtower
Tulsa, Oklahoma

FINANCING

MONEY TO PURCHASE oil loans, oil payments and oil royalties in Texas, Oklahoma and New Mexico. Baptist Foundation of Texas, 201-03 Baptist Building, Dallas 1, Texas.

Oklahoma Fields

(Continued from page 151)

Winn—Aladdin 1 Young, NW SW NW 32-12n-3e, pumped 19 bbl. from Bartlesville at 4,855-72 ft., TD 5,764 ft., Bartlesville 4,858 ft., May 5,115 ft., Woodford 5,301 ft., Hunton 5,392 ft., Sylvan 5,434 ft., Viola 5,535 ft., Deese 5,578 ft., dolomite 5,596 ft.

OKLAHOMA WILDCAT FAILURES

Bryan County: Samedan 1 Williams, NE SE NE 28-6s-7e, dry, TD 3,955 ft., Simpson 3,260 ft.

Cotton County: W. J. Hamilton 1 Kinnard, SE NW SE 23-5s-12w, dry, TD 1,820 ft.

Garvin County: Tide Water 1 Prince, SW SE SW 31-1n-2w, dry, TD 858 ft., Viola 700 ft.

Jefferson County: J. D. Wells et al 1 Seay, SE NE NE 28-6s-5w, dry, TD 1,583 ft.

Lincoln County: Four States 1 Ruboc, SE SE SE 4-13n-5e, dry, TD 4,545 ft., Viola 4,460 ft.

Oklahoma County: Sam Viersen et al 1 Beresford, NE NE SW 1-14n-4w, dry, TD 6,880 ft., second Wilcox 6,830 ft.

Osage County: A. G. Oliphant 1, NE NE SE 15-25n-4e, dry, TD 4,010 ft., Wilcox 3,841 ft.

Pawnee County: Olson Drilling 1 Gibbons, SW SW SW 5-20n-9e, dry, TD 2,453 ft., May 2,432 ft.

Schermerhorn 1 Houston, SE SE NE 13-20n-5e, dry, TD 3,210 ft., Bartlesville 3,169 ft.

Stephens County: T. H. McCasland 1 Reviere, NE NE NE 9-1s-5w, dry, TD 2,505 ft.

Tillman County: Honolulu Oil 1 Burba, NE NE NE 33-1n-17w, dry, TD 2,783 ft., in granite.

Canadian Fields

(Continued from page 147)

Steveville.—In the Steveville-Princess field, eastern Alberta, California-Standard Princess-C.P.R. 18-22A, LSD 16, 22-20-12w4, is on the pump at 3,961 ft. with initial production unreported. Two tests are drilling and two are standing.

Nova Scotia.—A survey of oil possibilities in Nova Scotia by Dr. A. E. Campbell, deputy minister of mines, shows that in recent years numerous surveys for oil and gas have been carried out in the province. Lion Oil Refining Co. of Arkansas last year drilled a 7,000-ft. test in the Mabou area, but was unable to secure a contractor to continue this year. Sun Oil Co. has rigged a test at Nappan with a heavy-duty outfit capable of 15,000 ft. and is drilling. Nova Scotia Gas Co. has commenced drilling at Kennetcook.

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Rocky Mountain Area

(Continued from page 148)

ton sand at 2,610-43 ft. It is only 8 miles south and east of a producer in the Madison recently completed in the Madison on the Hay Lake dome, southern Alberta.

Eastern Colorado test.—Fred M. Manning, Inc., and George Dickey 1 Ashbaugh, C NE NE 15-7s-59w, Buckingham district, Weld County, Colorado, encountered water in the Dakota at 6,798 ft., total depth, and is filling hole with mud.

New operations.—Twelve new operations were reported, of which 3 are in the Rangely field in Colorado; 1 at Gebo, in Wyoming; 2 at Pondera, 2 in Cat Creek, 3 in Kevin-Sunburst, and 1 in the Baker gas field, in Montana. All are development wells.

Completions.—Twelve wells were completed in the Rocky Mountain area of which 9 were oil wells and 3 were gas wells. Only one was a wildcat, a gas well in Utah.

UTAH SUCCESSFUL WILDCAT COMPLETION

Farmham, Carbon County: Carbon Dioxide & Chemical Co. 1 Government, NW NW NE 12-15s-11e, TD 3,246 ft., top Morrison 3,212 ft., 7-in. perf. at 3,212-28 ft., 5,000,000 cu. ft. carbon dioxide gas.

MARKET QUOTATIONS

Prices as of December 11, 1945

(This service is abbreviated because most refinery products are selling at the Government's price ceilings. Quotations on other products than those shown here furnished on request. Quotations are f.o.b. plant in tank cars and in cents per gallon.)

REFINERY GASOLINE

Octane (A.S.T.M.)	78-80†	73-75
Mid-Continent*	6.50-6.75	5.75-6.00
Gulf Coast	6.75	5.750
Northeast Coast	...	9.875
California	...	6.50-7.00

*Basic Oklahoma Group 3. †1939 C.F.R. (research method).

NATURAL GASOLINE

Grades:	26-70	18-55
Oklahoma (Group 3)	4.500	5.400
North Texas (f.o.b. plant)	3.500	4.200
North Louisiana (f.o.b. plant)	3.750	4.500
California	4.875	5.500

CRUDE-OIL PRICES

Representative posted schedules per bbl.	
East Texas	$1.25
Conroe	1.49
Tepetate, Louisiana, avg. grav.	1.20
Illinois Basin	1.37
Pecos County, Texas	.95
Bradford, Pennsylvania	3.00
Van, Van Zandt County, Texas	1.09

Note: Exclusive of subsidy.

GRAVITY SCHEDULES

Top prices include all gravities above grades designated, and low prices include all gravities below grades designated:

Gravity—	Signal Hill, Calif.	Okla-homa Kansas	Gulf Coast Texas	West Tex.*
18-18.9	$0.80	...		
19-19.9	.84		$1.06	$0.70
20-20.9	.88	$0.85	1.08	.72
21-21.9	.92	.87	1.10	.74
22-22.9	.96	.89	1.12	.76
23-23.9	1.00	.91	1.14	.78
24-24.9	1.03	.93	1.16	.80
25-25.9	1.07	.95	1.18	.82
26-26.9	1.11	.97	1.20	.84
27-27.9	1.15	.99	1.22	.86
28-28.9	1.18	1.01	1.24	.88
29-29.9	1.20	1.03	1.26	.90
30-30.9	1.23	1.05	1.28	.92
31-31.9	...	1.07	1.30	.94
32-32.9	...	1.09	1.32	.96
33-33.9	...	1.11	1.34	.98
34-34.9	...	1.13	1.36	1.00
35-35.9	...	1.15	1.38	1.02
36-36.9	...	1.17	1.40	1.04
37-37.9	...	1.19	1.42	1.06
38-38.9	...	1.21	1.44	1.08
39-39.9	...	1.23	1.46	1.10
40 and above	...	1.25	1.48	1.13

*Includes Lea County, New Mexico.

A.P.I. REFINERY REPORT

Week ended December 1, 1945

(Figures in thousands of barrels)

	Dly. crude runs to stills	Stocks Gasoline	Stocks Distillate	Stocks Residual
East Coast	828	18,562	15,593	8,008
Appalachian	162	3,527	768	426
Ill., Ind., Ky.	740	17,193	6,352	3,141
Okla., Kan., Mo.	362	7,606	2,808	1,108
Inland Texas	219	2,881	435	950
Tex. Gulf Coast	1,065	14,989	5,993	4,834
La. Gulf Coast	324	3,910	1,990	1,589
North La., Ark.	58	1,726	525	339
Rocky Mt.	127	1,733	531	754
California	805	13,859	9,279	25,385
Total 12- 1-45	4,690	*85,976	44,274	46,534
Total 11-24-45	4,648	83,184	45,258	46,474
Total 12- 2-44	4,725	80,689	45,385	61,944

*Military 26,492. Civilian 59,484.

CRUDE-OIL STOCKS

(Bureau of Mines Estimate)

Week ended:	Bbl. of crude*
December 1, 1945	218,845,000
November 24, 1945	219,363,000
December 2, 1944	221,591,000

*Excludes unrefinable California stocks.

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